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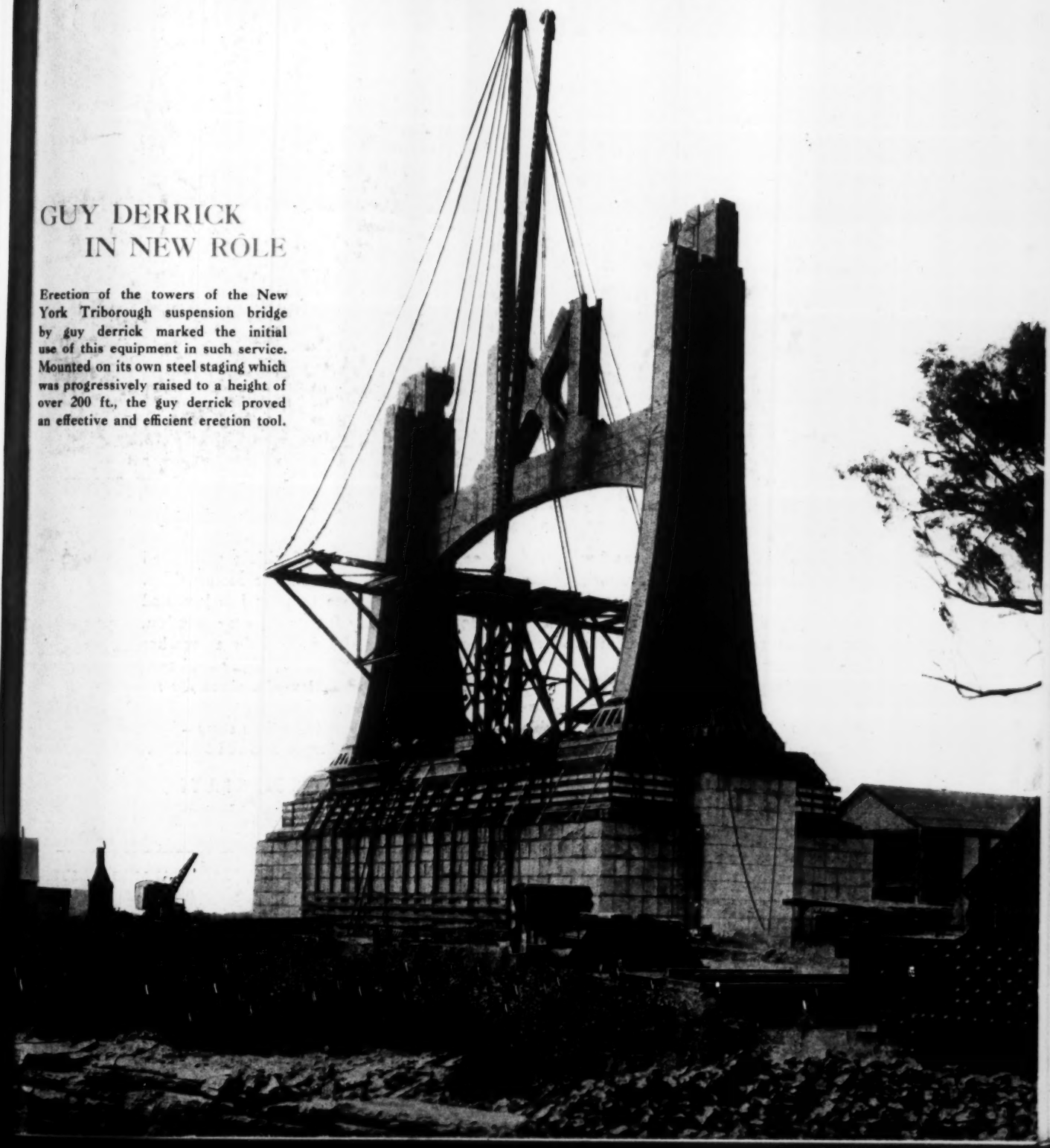

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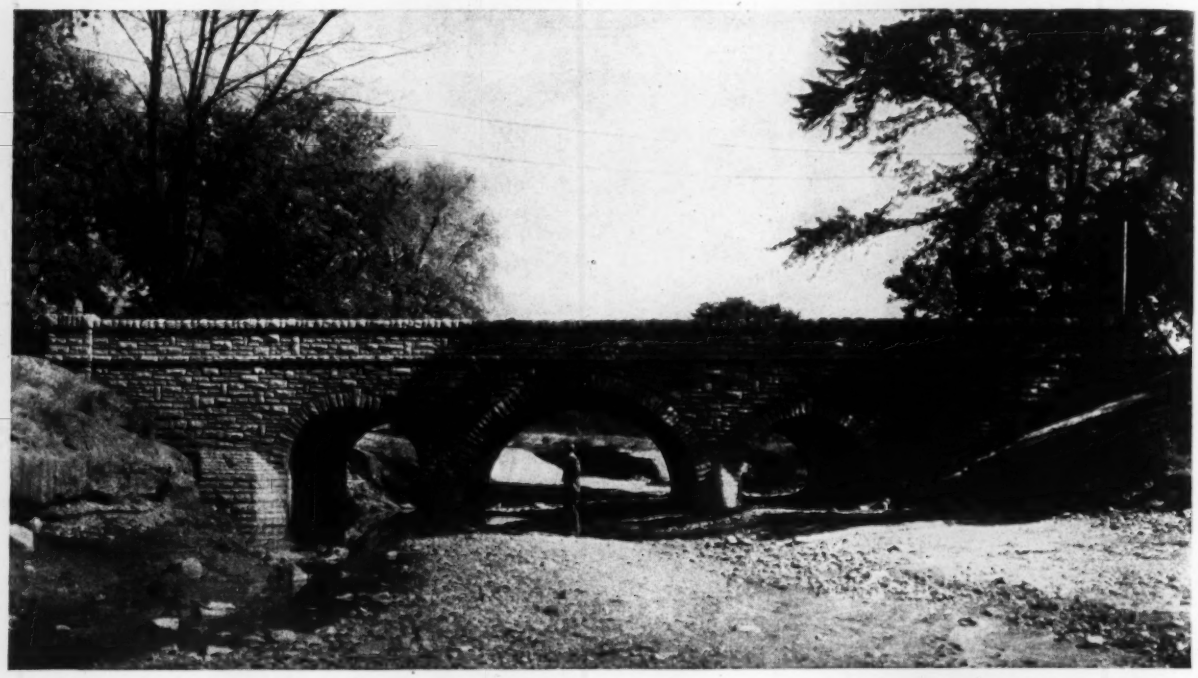

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Just *Another* Ship

NOT so long ago a new ship glided through the Narrows and up to her berth on the Hudson. It was the Normandie, completing her maiden run with a new speed record safely tucked away in her vanity bag—or wherever it may be that ocean queens cherish such trophies.

New York gave her the works. As she held her stately course up the river a shuttling host of escorting craft wove unceasingly about her a pattern of acclaim. More lowly sister-vessels filled the air with the din of their welcome. To do her honor, city fire-boats draped themselves in the filmy veils of their most graceful streams. Nervously a flock of planes darted, dipped and zoomed overhead while more sedate dirigibles floated leisurely above her. From the Battery to her berth, waiting thousands lined the piers, bulkheads and office windows to cheer, to wave or just to look. Down the harbor and at her pier welcoming delegations waited to do their stuff.

And the newspapers; what a run they gave her! News, editorial and advertising pages all announced, acclaimed or capitalized her advent. Producers of fuel, luggage, furniture, men's straw hats and women's frocks, operators of theaters and apartment houses, publishers of newspapers—all these and many more vied in tying their interests by some thread, however tenuous, to the sensation of the day. "When you think of the Normandie," they said in effect, "think of us!"

FOR it was the Normandie's day; the Normandie was the BIG NEWS.

She berthed, the formal welcomes were spoken and the photographs snapped. The passengers debarked and went their ways. A few hours later, at this writer's window, a visitor looked out at the ship lying at her pier. Gone were the crowds, the planes and the dirigibles; river traffic plowed its stolid way, its whistling confined to the practical business needs. The curtain had fallen; the show was over. The visitor remarked, "Now she's just another ship."

And sure enough, from that point even the Normandie will be just another ship. She has had her big day. For that day she was news—*the* news. What though much of the acclaim was the result of studied press-agentry and organized ballyhoo? Most of it was genuine; she was big news in her own right and she rated her welcome. But now all that is over. She is just another ship.

From now on even the Normandie must be sold. A great steamship company must mobilize its resources, a great advertising agency must bend its skill and effort to keep her alive in the minds of those who travel. Six months hence the Normandie may be in fact the same ship that she is today; but *in her own right* she no longer will be news.

To be sure, she can be kept in the news by conscious design, intelligent planning and consistent effort. She will be made news with those to whom it matters through the advertising pages of publications that circulate among potential travellers and through other mediums. Her owners know that they cannot now sit back, secure in their position and just book the sailings as they come in over the transom. They know better than that; they know that this brief monopoly of the public interest is but a good start; now they must begin a never-ending effort to keep their splendid ship before their prospects. From now on its advertising must compete with newer news—news of politics, crime, earthquake, flood, fire, sports—yes, and of competing ships.

AND so it is with every new product under the sun. Like the Normandie, it may have its day; how big a day will depend on the resourcefulness and enterprise of its producers. But that day once past, it will be news only as the producer makes it news, it will be known to its prospective users only as he makes it known, it will hold its position only so long as consistent performance backs up consistent presentation.

To help with this vital job is the function of advertising. And unless this job be done wisely, impressively and consistently, even the finest fruits of man's genius soon become "just another ship."

Willard Chevalier

ENGINEERING NEWS-RECORD

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In the News:

Floods in the Central States loom up large in headlines where last year at this time drought and dust storms were most prominent in national interest. Nor are the current floods the result of sporadic storms of unusual intensity. Rather, they are the result of a repetition of storms, one coming close upon another before excess flows have had time to run off. Streams in Wisconsin were over their banks nearly two weeks ago before the rains of last week began, and much the same thing is true of the Muskingum Valley in Ohio.

Stringing of the catwalk cables for the Golden Gate Bridge at San Francisco has been begun. Spinning of the cables will be under way by early fall.

A Jury in Spokane, Wash., has found that land upon which the Grand Coulee Dam is being built is worth about $17,000 instead of the $5,000,000 claimed by the owners. Engineers who testified for the government found themselves in the peculiar position of arguing that the project was not attractive as a business undertaking.

With WPA Operations Lagging, efforts are being made in Washington to revive interest in PWA combined loans and grants. Under the revised PWA setup as regards labor limitations, such projects are expected to avoid the labor difficulties that have slowed up the WPA. Meanwhile, the minimum work week on WPA projects has been cut from 140 to 120.

Options on a 17-acre site on the Northwest Side at Chicago have been accepted by the PWA, the fourth project to get under way in that city. A 37-acre site in Oklahoma City also has been acquired.

The President has signed the Motor Carrier Act, putting interstate operations of common carrier and contract carrier trucks and buses under the I.C.C., thus giving that body a new significance to the highway builder.

Disapproval of WPA security wages by hotheads in labor organizations culminated last week in strikes of workers on WPA projects, notably in New York, where the stage was set for a controversy in which the issue may be settled for the whole country. As this is written, the strikers appear to be coming to their senses and going back to work.

In This Issue:

After Many Years, steel has again come to the fore as a material with which to make dams watertight. At least three dams with steel faces are under construction or have been completed within recent months. Most interesting of them is the El Vado Dam in New Mexico, a rockfill structure 175 ft. high, with a welded steel diaphragm covering the upstream face. Steel also was used extensively in the spillway channel and diversion tunnel. From a construction standpoint, the deep cutoff wall is notable.

John F. Stevens' recollections are resumed in this issue with the first of three articles on "Early Days at Panama." In the current article he reviews his part in the famous controversy of a lock vs. a sea-level canal.

A nationwide survey of sewage-disposal facilities, showing the number of sewers and plants, the major units of treatment and many more detailed data compiled from information supplied by state sanitary engineers is presented as an insert in this issue. An inventory of this kind in a specialized field has considerable value as an unusually complete source of reference for the many municipal, state and federal agencies who constantly have recourse to this type of information.

Guy Derricks were used successfully for the erection of the 270-ft. towers of the Triborough Bridge over the East River at New York. As this is a departure from usual practice in the erection of suspension-bridge towers, the operations are described in detail in this issue. The article supplements the general article on the bridge project in the Aug. 8 issue.

Geophysical Prospecting has been used succesfully in exploring for oil, and to a lesser extent in locating subsurface deposits such as gravel. In recent years experiments have been conducted on the applicability of these methods in determining underground conditions of importance to highway builders. In this issue the studies conducted by the U. S. Bureau of Public Roads, using the electrical-resistive and the seismic methods, are reviewed.

The Activated-Sludge Type of sewage treatment, usually placed in the category of recently developed methods of purification, has been producing a good plant effluent in San Marcos, Tex., for nineteen years. This installation, representing the first of its kind in the United States, is described by Professor Steel, of Texas A.&M. College.

Modern Water Collection, treatment and purification facilities have been completed for Ankara, new capital of the republic of Turkey, where the first water-supply system was installed by the ancient Romans. Underground sources have been tapped, and an impounding reservoir constructed to insure adequate supply for 84,423 inhabitants of a city estimated to have been occupied since 2000 B.C.

Floods in the Muskingum Valley have been conspicuous in the news within the last few days. In this issue will be found a progress statement concerning the work of eliminating the losses caused by such floods through the construction of fourteen flood-control reservoirs.

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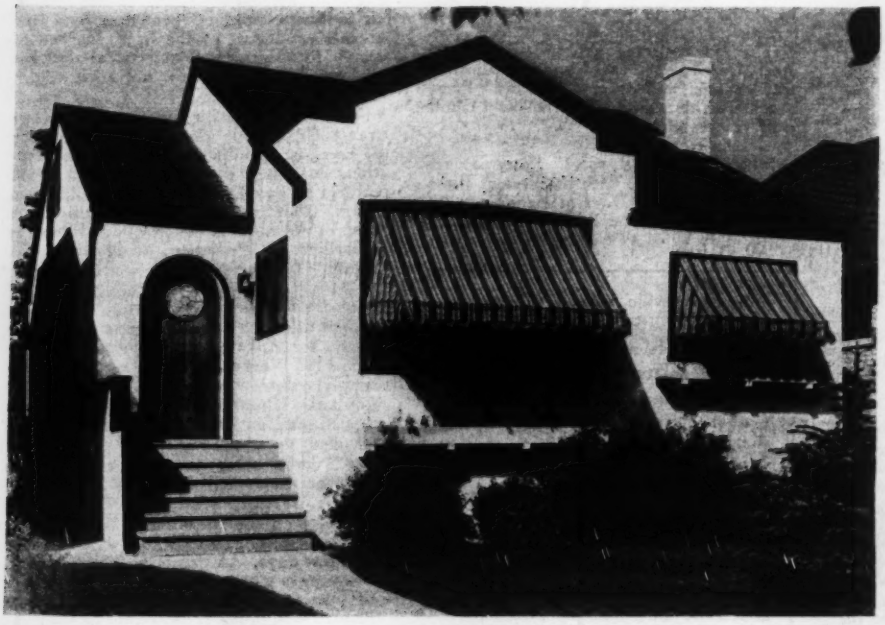

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This trim and tidy home has been modernized with an Atlas White portland cement stucco finish in a semi-rough texture.

ENGINEERING NEWS-RECORD

August 15, 1935

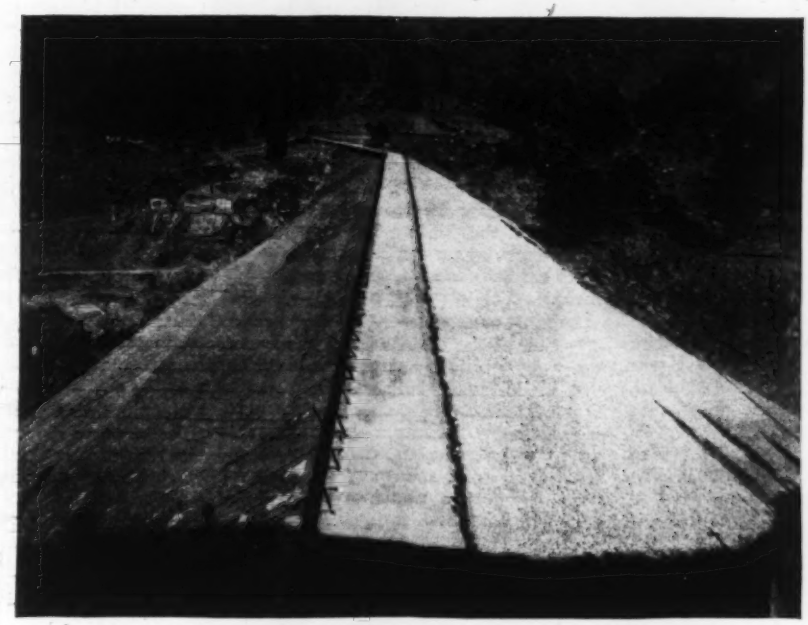


FIG. 1—EL VADO DAM is a rolled gravel fill made watertight by a facing of welded steel plates fixed to a concrete cutoff wall along the entire toe of the upstream face.

Steel Used Extensively in Building El Vado Dam

Welded steel plates used to make a watertight upstream face and to line the spillway channel—Steel liner plates employed in forming part of the permanent lining of the diversion tunnel—Cutoff wall presented the major construction problem

By Chas. P. Seger
Resident Engineer, El Vado Dam, Chama, New Mexico

PLATE STEEL was used extensively in the construction of El Vado Dam in New Mexico, more extensively than was called for in the original design of the structure (*ENR*, June 26, 1933, p. 504). The dam, recently completed by the Middle Rio Grande Conservancy District, is a gravel fill, 1,300 ft. long and 175 ft. high above streambed, faced with welded steel plates. It is located on the Chama River near the New Mexico-Colorado line and is part of the district's program for flood control, irrigation and drainage in the Rio Grande Valley (*ENR*, June 12, 1930, p. 963). The catchment basin covers an area of 650 square miles, with an estimated annual runoff of 400,000 acre-ft., of which 198,000 acre-ft. can be stored in the reservoir formed by the new dam.

Steel was also used for a wave parapet on the top of the dam, for lining the spillway channel and as an important element in lining part of the combined river diversion and outlet-works tunnel.

Details of the steel-plate facing, as called for in the original design (*ENR*, Oct. 26, 1933, p. 504) were changed somewhat during construction. The revised design is given in the accompanying drawings. Other changes were made from the original design due to developments during construction, as will be noted subsequently.

The design also called for a concrete cutoff wall along the upstream toe of the dam to which the steel face was to be fixed. Construction of this wall turned out to be the major construction operation of the whole undertaking. It is described first, as the operations are reviewed herein in chronological order.

Cutoff wall

To make possible a clear understanding of the problem presented by construction of the cutoff wall, it is necessary to outline briefly the underground conditions that were encountered. The streambed and right abutment are composed of heavy layers of sandstone, sandy shale and shale and offered a good anchorage for the structure. The left abutment is composed of broken sandstone and sandy shale interspersed with clay and soil, remnants of ancient landslides. For a distance of about 600 ft. to the left of Station 2 + 80 (Fig. 3) a

layer of gravel 2 to 3 ft. thick, and 90 ft. above the riverbed had been overridden with a sandstone cap 70 to 80 ft. thick. This gravel layer being nearly impervious and the sandstone cap possessing good continuity, the whole mass was consolidated with pressure grout.

Between station 2 + 80 and 5 + 30, it was necessary to remove all the broken formation to depths of 90 to 130 ft., in order to land the cutoff wall in undisturbed shale. From Station 5 + 30 to 9 + 30 the landslide remnant lying over the undisturbed shale was incorporated in the cutoff wall by pressure grouting.

The grouting was done through one line of 2-in. holes, 20- and 40-ft. depths, at 5-ft. centers, and two lines of 4-in. holes, 70-ft. to 80-ft. depths, at 5-ft. centers. From Station 8 + 40 to 9 + 60 a bed of river gravel, 8 to 10 ft. thick and lying 40 ft. below the riverbed, was removed in line with the cutoff wall, and the space was then refilled with concrete.

Grouting pressure varied from 60 to 100 lb. depending on the location and character of the hole. Sand was used only when the hole had taken an excessive amount of neat cement grout.

A total of 18,820 lin.ft. of grout holes were drilled, and 28,739 cu.ft. of grout were injected into the foundation. Well rigs equipped with 4-in. tools were used for drilling deep test holes, which were later filled with grout. Logs were obtained by samples taken from the bailer.

The cutoff wall is 36 in. thick, reinforced with 1-in. round bars spaced at 12-in. centers both ways and in both faces, and extends 5 ft. into solid sandstone or shale. No reinforcement was used more than 30 ft. below the ground surface.

As the gravel fill was being constructed at the same time as the deep portion of the cutoff-wall excavation was being carried on, it was necessary to excavate for and construct the upper section of the wall in order to provide anchorages for the steel face plates, which were erected in advance of the embankment.

Mining methods were used in the excavation of the deep portion of the cutoff wall, working shafts sunk at about 100-ft. intervals being equipped with 20-cu.ft. mine skips operated by gasoline hoists. The area between these shafts was stoped out, starting from the bottom on solid shale and working up. The drifts were timbered with square sets 3 ft. wide by 6 ft. high in the clear.

FIG. 2—THE METAL FACE of El Vado Dam is of steel plates welded into sheets 25 ft. long between expansion joints.

The posts and caps were framed from 8x8-in. timber, and the lagging was of 2-in. material.

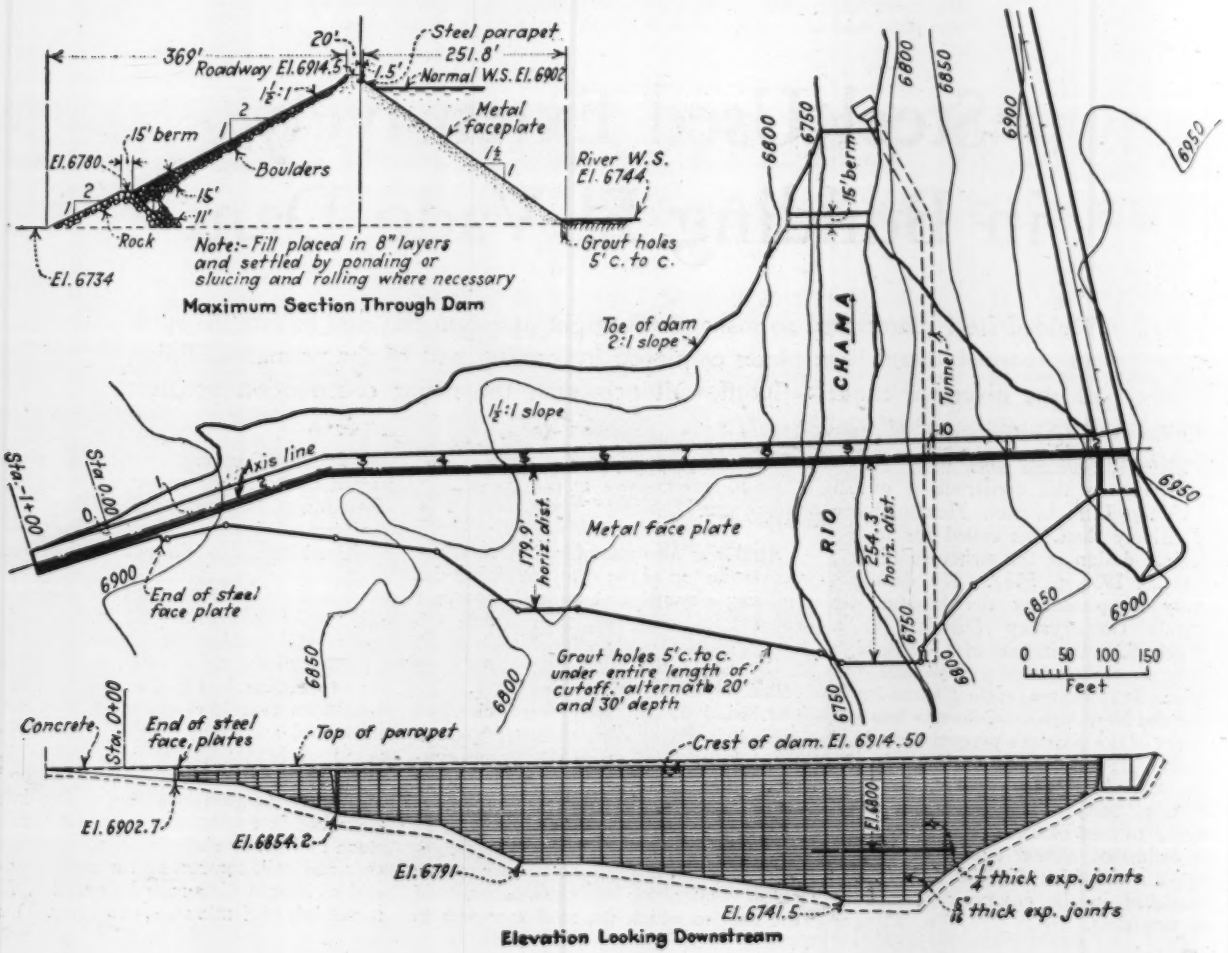
When two or more horizontal drifts were stoped out between shafts, the lower was completely filled with concrete. This procedure was repeated until the upper portion of the wall already in place was reached and a connection made. In places where the ground was especially bad it was necessary to raise to the surface and place the concrete in vertical sections. The concrete was shot down the shafts through 6-in.-diameter pipes and distributed horizontally with chutes. Keyways and metal waterstops were provided in the concrete between sections.

All traverse timbers, such as caps and struts, were removed before concreting and replaced with 4x4-in. precast concrete members, which remained in the finished wall. Lagging was removed where the ground was stable; all posts and girts were left in.

A total of 8,800 cu.yd. was excavated by the above methods in ten months against an estimated time of one year.

Gravel embankment

Suitable gravel for the embankment was found above the riverbed within about a mile of the dam site. The mate-



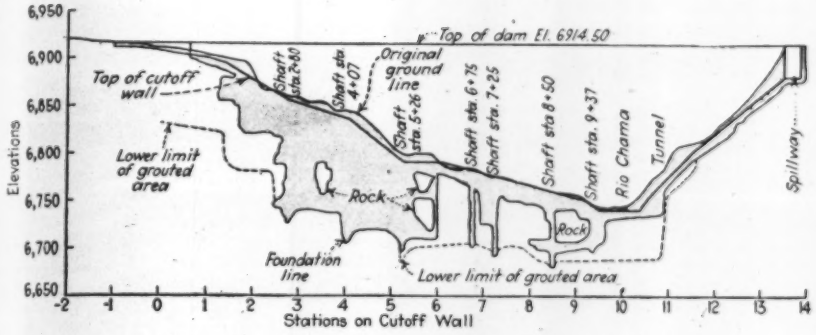


FIG. 3—THE CUTOFF WALL had to be carried deep into the left bank because of the shattered condition of the rock.

rial was well graded, from 8- to 10-in. cobbles down to fine sand and clay. The gravel deposit was covered with a heavy layer of earth averaging about 10 ft. in thickness, and the gravel bed was about the same thickness. Draglines stripped the pit, and a 1½-yd. shovel loaded 3-yd. dump trucks. Haulage was effected by contract, loading, spreading, sprinkling and rolling by the district's forces. The gravel was spread in 8-in. layers with bull dozers, followed by sprinkling and rolling with a 10-ton roller. Truck travel was well distributed to add to the compaction.

As the large cobbles made spreading and rolling difficult, they were picked up by hand, hauled by small trucks and placed on the downstream slope, forming a heavy protective covering from 3.5 to 16 ft. thick.

A good road was maintained at all times from the pit to the dam. All roads were graveled, and 1 mile of the main road was oiled.

The maximum amount of gravel loaded and hauled onto the dam in one shift was 1,654 cu.yd. The contractor had fifteen trucks, with an average of thirteen in the line. The total volume of gravel in the dam was 598,620 cu.yd., and it required seven months to place it. A rock fill of 9,200 cu.yd. at the downstream toe of the dam was constructed by the district's forces.

Steel face of the dam

The upstream slope of the gravel fill is protected from percolation and wave action by ¼-in. steel plates welded together and anchored to the top of the concrete cutoff wall. The plates are 100 in. wide by 24 ft. 5 in. long, laid on the 1½-to-1 gravel slope longitudinally, with welded lap joints and with vertical expansion joints provided at 25-ft. centers. The plates were erected on light structural-steel horses and followed closely the gravel-fill construction. The horses remained in the fill.

FIG. 4—LARGE COBBLES from the filling material were used to make the protective blanket for the downstream slope.

Backfilling immediately under the steel plates was done by hand. Extreme care was taken in tamping the gravel and in the application of water, to insure uniform compaction and a true line of the face plate.

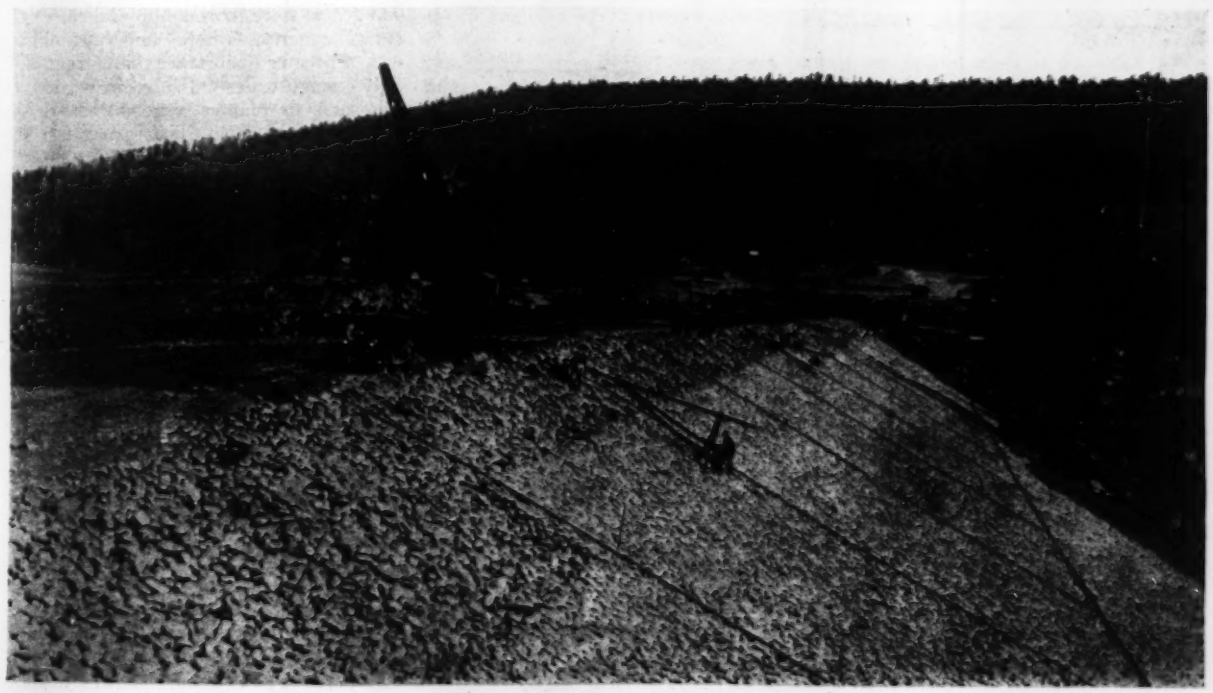
A total of 1,244 tons of metal was used in constructing this 5-acre protective steel face, and 60,000 lin.-ft. of electric welding was necessary to fabricate the job.

A parapet of steel plates, curved similar to a seawall, was attached to the top of the steel face and anchored to concrete beams in the gravel fill. The parapet was further stabilized by constructing the gravel embankment to its top. After welding, the steel face was given an undercoat of red lead and a protective coat of metallic paint. The steel face and parapet were erected and welded by contract.

Diversion tunnel

A standard horseshoe tunnel 12 ft. in diameter was constructed through the right abutment of the dam for diversion of the river during construction, and was later plugged and utilized as a gallery for installing the regulating works and as a permanent passageway to the emergency butterfly valve.

Standard practice was used in the excavation of the tunnel. For the most part a hard sandy shale and sandstone were encountered, requiring some timbering. The material shot out very blocky, and the overbreakage was large. The intake end of the tunnel was lined with concrete for a distance of 90 ft. The remainder of the tunnel except the floor was lined with steel liner plates, to



which was attached wire-mesh reinforcement. A 3-in. layer of Gunite was applied, to add strength and to improve the hydraulics. Loose rock was packed outside the liner plates and pressure-grouted at 32-in. intervals. The tunnel floor was of concrete. This type of lining was adopted over concrete, to expedite the work, and with the excessive overbreakage it proved more economical.

A structural-steel trash rack protects the tunnel from floating debris.

Spillway

The spillway, located in the right abutment of the dam, was excavated by contract, the contractor using a 1¼-yd. shovel and trucks to do the job. The channel is 1,000 ft. long with a base 36 ft. wide at the intake and 20 ft. wide at the outlet end. The material taken out, for the most part, was shale varying in hardness from soil to rock that weathered quite rapidly when exposed. Because of this weathering and the resulting overbreakage, steel was used for a lining instead of concrete. Steel plates were used, ¼ in. thick on the sides of the chute and ⅛ in. thick on the floor; all were welded to 4-in. tee-beams anchored in composite concrete and Gunite beams spaced transversely at 8-ft. 4-in. centers. All steel fabrication was by contract.

An automatic radial gate 36 ft. wide and 23 ft. 6 in. high controls the flow of the spillway. New principles were used in the construction of this large gate. Instead of two radial arms at the ends of the gate hinged on pins at either side of the gate structure, as is the general practice, five arms equally spaced were used, and these were hinged on a concrete traverse beam cast monolithic with the structure. By this construction a saving of about 50 per cent in metal was effected and a more rigid job was obtained. The computed discharge of the structure with the water at the crest of the dam is 20,000 sec.-ft.

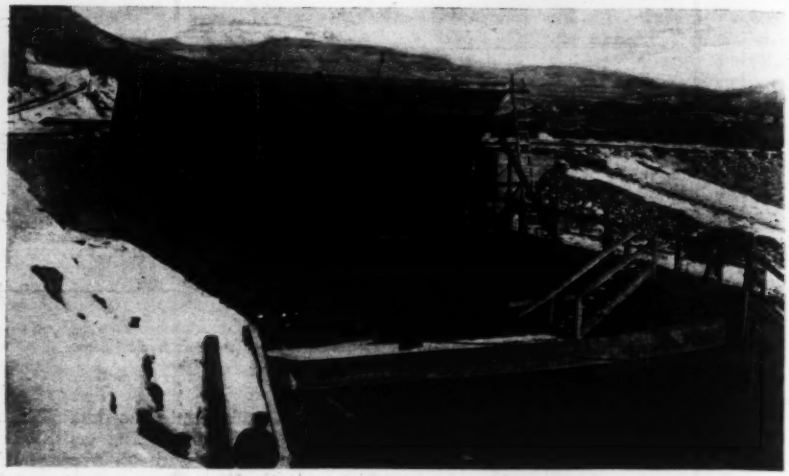


FIG. 6—THE SPILLWAY GATE is unusual in that there are five radial arms framed into a transverse concrete beam at the hinge.

Concrete of a strength of 5,000 lb. per sq.in. at 28 days was used in the construction of the spillway.

Types of concrete used

Concrete aggregates were obtained from the adjacent riverbed and processed through a crushing, screening and washing plant with a capacity of about 100 cu.yd. per eight-hour shift.

For high-strength concrete, both sand and gravel were thoroughly washed. For cutoff concrete where impermeability was of greater importance than strength, only enough water was used in washing the sand to remove vegetable matter, leaving in as many fines passing the 100-mesh sieve as possible. This made for workability and watertightness with a minimum of cement.

Cement of such fineness that 97 per cent passed the 200-mesh sieve was used for most of the cutoff wall. With this fine cement, 4.3 sacks of cement were used per cubic yard of concrete, while with standard cement 5 sacks per cubic yard were necessary to obtain satisfactory results. Most of the concrete was mixed at a central plant, equipped with two ½-yd. mixers and a boiler for heating water and aggregates during cold weather. Scales were used for proportioning the sand and gravel; cement was measured by the bag, and the water by the mixer valve and tank, frequently checked by weighing. A control man was on the job at all times, and a uniform water-cement ratio concrete was produced. Test cylinders were taken frequently and broken at 7-, 28- and 60-day periods. The results showed a uni-

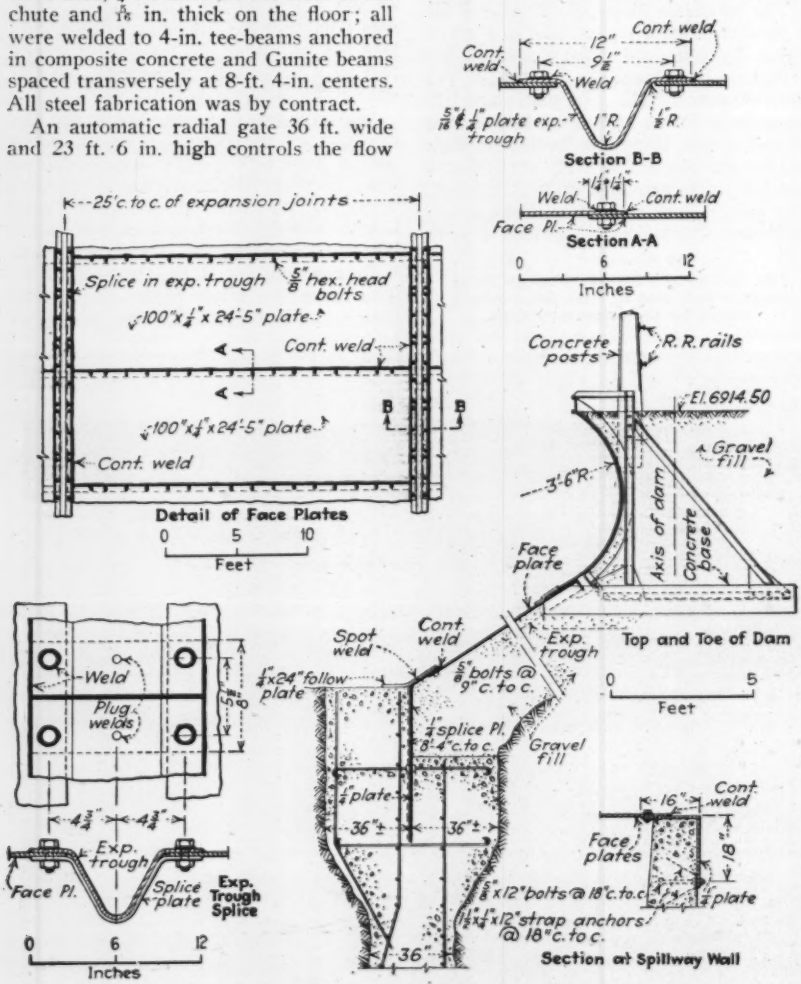


FIG. 5—FACE PLATE DETAILS, including the expansion joints, anchors to the cutoff wall and the parapet.

form strength equal or above that called for in the designs.

After mixing, the concrete was discharged into small dump trucks and hauled to the various parts of the job. Slumps of 4 to 6 in., were used, depending on the class of work, and internal vibrators were used with the stiffer mixes. All exposed concrete was water-cured for twenty days, and in freezing weather it was steam-cured for the same period.

Outlet works

Stored water will be released from the reservoir through the 36x23½-ft. radial gate until the water surface in the reservoir reaches the sill; below this point the outflow will be discharged through a 78-in.-diameter steel penstock inside the 12-ft. diversion tunnel. At the upper end of the penstock a 78-in. emergency butterfly valve, hydraulically operated, is installed. At the lower end of the penstock two new valves of a type known as the Howell-Bunger valve will regulate the flow. These valves were designed by C. H. Howell and H. P. Bunger of the district's engineering force. Briefly, they consist of a horizontal sleeve which slides over a cone. The sleeve is moved forward to close and backward to open. The water leaves the valve in the shape of a hollow cone instead of a jet, as in the case of a needle valve. The valve is simple and much cheaper than any other type of high-head valve.

The penstock pipe, 635 ft. long, is constructed of ⅞-in. plate electrically welded at all joints.

Financing and organization

The construction of this structure was financed by the sale of bonds to the Reconstruction Finance Corp. Generally the work was accomplished by force account, certain features of the job being effected by contract as follows: gravel haulage for embankment, 598,620 cu.yd. by the Springer Transfer Co., Albuquerque, N. M.; excavation of spillway, 80,000 cu.yd., by Frank Shufflebarger, Albuquerque, N. M.; erection and fabrication of steel face plate, parapet and penstocks, 1488 tons, by the American Bridge Co.; erection and fabrication of steel lining for spillway, 458 tons, by the Wyatt Metal Boiler Works, Dallas, Texas.

Good progress was made in the construction of this dam in spite of unforeseen and adverse foundation conditions. It was thought that three years would be necessary to complete the structure, but the job was finished in two years. This saving in time may be assigned mainly to favorable weather conditions and the use of steel for facing the dam.

The dam was built under the authority of the board of commissioners of the Middle Rio Grande Conservancy District, with C. H. Howell as chief engineer, H. P. Bunger as designing engineer, and D. C. Henny, Andrew Weiss, Raymond E. Davis, E. H. Wells and Kirk Bryan acting in consulting capacities. The field work was under the supervision of H. V. R. Thorne as construction superintendent and the writer as resident engineer.

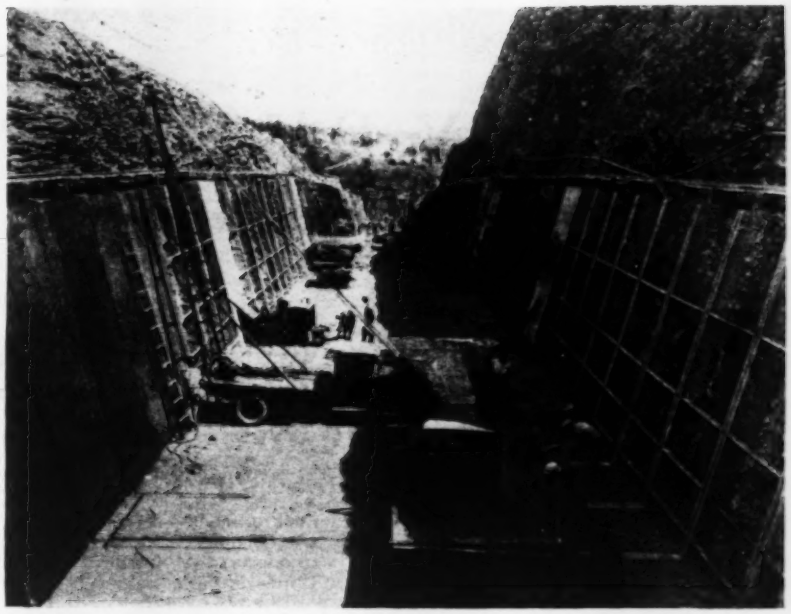


FIG. 7—THE SPILLWAY CHANNEL, because of the character of the rock and the amount of overbreak, was lined with steel instead of concrete.

Since this article was written, C. H. Howell has left the Middle Rio Grande Conservancy District and is now chief engineer for the Los Angeles County Flood Control District, California. Mr. C. A. Anderson is now chief engineer of the district.

Inspection of Aluminum Bridge Floor

IN ANSWER to recent questions as to the condition of the aluminum floor framing and decking on the Smithfield Street Bridge over the Monongahela River in Pittsburgh, a report of excellent condition is made by Charles M. Reppert, chief engineer of the city's department of public works. In particular, rumors that a number of rivets in the floor had been found loose are disposed of by Mr. Reppert in the statement, "There are no loose rivets in the Smithfield Street Bridge floor."

A thorough inspection of the floor was made last June after it had been in service a little more than seven months; a movable scaffold was provided so that the under side of the bridge floor could be included in the examination. The inspecting group included representatives of the department of public works and of the Aluminum Company of America, which furnished the material and also carried on extensive service tests in the development of the special channel and plate floor slabs used. The inspection report states that, "After seven months of service the new aluminum alloy floor for the Smithfield Street Bridge is in excellent condition. A few open holes were found where bolts or rivets had been left out. A number of poorly driven rivet heads were found but never in locations which would cause this to be of any importance. It was quite difficult in the actual inspection to find any conditions important enough to warrant making any notations. The paint coating is in first-class condition. Mechanically the floor is in the good condition which one would expect of a well-designed and carefully fabricated structure after a short period in service." It will be recalled that the rivets in this aluminum construction are of steel (*ENR*, Nov. 23, 1933, p. 611).

A further inspection was made by engineers of the department of public works a few weeks ago, in which floor-beam splices were examined at three points and connections between stringers and floor beams at about 60 connections. No loose rivets nor any evidence of loose joints were found. Mr. Reppert's general conclusion is: "So far as the engineers and inspectors of the Division of Bridges and Structures can determine, the aluminum floor system on the Smithfield Street Bridge is behaving in the same manner as a structural-steel floor system of similar design would behave."

An Engineer's Recollections—IX.

EARLY DAYS AT PANAMA

By JOHN F. STEVENS

Consulting Engineer,
Baltimore, Md.

The Question of Sea Level vs. Lock Canal

Converted from a favorable attitude toward a sea-level canal, Mr. Stevens, on seeing the conditions to be met, threw the weight of his influence in favor of a lock canal, despite formidable opposition

EDITOR'S INTRODUCTION—Congress, by an act passed in 1903, authorized the President to take over all the French property and rights in Panama, and provided money for the start of construction of the Panama Canal with American forces. Appointment of an Isthmian Canal Commission was authorized at the same time. In February, 1904, the Hay-Bunau-Varilla Treaty was ratified, and in the same month the Isthmian Canal Commission, consisting of two retired officers of the Army and Navy and five civilian engineers, was appointed. In June of that year John F. Wallace was appointed chief engineer.

Those who undertook the actual field work faced a more discouraging scene than they would have had to face had the French never attempted to build a canal across the Isthmus of Panama, for they had ever before them the record of the losing fight of the French against yellow fever and other tropical diseases, and around them were the remains of the abandoned French construction and plant. Added to their hardship was an endless snarl of red tape. In the first place, the commission was too large to function effectively, and, sitting as it did in Washington many hundreds of miles removed from the job, it could not appreciate the needs of those on the job; also its staff, recruited largely from government bureaus, was more concerned with seeing that the required number of forms were submitted for requisition for food or medicine, than with seeing that food reached hungry men or that medicine was available to protect them against disease.

The result was inevitable confusion, delay and discouragement. John F. Wallace, Col. W. C. Gorgas and others under them pushed forward the preliminary work as best they could, Mr. Wallace meanwhile protesting to the President against the handicaps under which they had to work. In March, 1905, President Roosevelt, unable to persuade Congress to authorize the appointment of a smaller commission, appointed a new commission, with Theodore P. Shonts as chairman. Mr. Shonts with Mr. Wallace and Charles E. Magoon, counsel for the original commission, made up the executive committee. He also appointed Mr. Magoon governor of the Canal Zone and required that the commission meet quarterly in the Zone. Thus, a far greater amount of control over the work was centered in the two men resident in the Canal Zone—Mr. Magoon and Mr. Wallace.

But the change came too late as far as Mr. Wallace was concerned. In June, having received an attractive offer of a position back in the United States, Mr. Wallace resigned and John F. Stevens was appointed chief engineer.

One of the questions left undecided when the canal work was undertaken was the matter of whether a lock canal or a sea-level canal should be built. Advocates of both were equally active in pressing their claims upon Congress. About the time Mr. Stevens was appointed to the position of chief engineer Congress authorized the appointment of a consulting board made up of eminent American and foreign engineers to advise the President on this question.

This is the background against which Mr. Stevens began his work at Panama. In the article that follows, Mr. Stevens tells how he was led to endorse the lock canal and of some of the closely related subjects. In two subsequent articles Mr. Stevens, who continued as chief engineer until construction of the canal was turned over to Colonel George W. Goethals, tells of the work of the civilian engineers who carried forward the operations under his direction. —EDITOR.

THE STORY of the attempt of Count DeLesseps to build an interoceanic canal across the Isthmus of Panama is well known. Fresh from the successful completion of the Suez Canal, he undertook the task of digging a sea-level ship canal at one of the most forbidding spots on earth, from a construction standpoint. He soon discovered that such a task was vastly different from the one he had carried out at Suez.

The difficulties, unforeseen and unprovided for, were amply recorded by the forced changes in plans in the famous Culebra Cut; first to a one-lift high level, then to higher levels and more locks, all of which were plainly evident on the ground when I reached the Isthmus in 1905. He failed in his tragic but brave attempt, as Americans would also have failed under conditions similar to those that he encountered.

Apart from the many other important problems which had not been solved since the American occupation, there was the very vital one of what type of canal should or could be built, sea-level or lock; as a matter of cold fact at that time, upon a correct solution of that problem depended the decision as to whether or not we would have a practical canal of any kind in return for our venture. Both types had their adherents, but few other than engineers had any competent knowledge that entitled them to an opinion. Most non-engineers were attracted by the alluring phrase "sea-level."

I went to the Isthmus with an open mind, rather I think in favor of a sea-level canal; but a brief study of the conditions met there forced me to the conclusion that a genuine canal of that type was an impracticability. Unless such a canal were built of great width, probably half a mile, one lock at least would be necessary on account of the 20-ft. difference in the tide levels of the two oceans.

Pending the formal consideration of the matter of type, the President appointed an international board of engineers, consisting of four Europeans and four Americans, all eminent in their profession, who were to examine conditions, collect data, call witnesses and attempt to solve the problem.

This board convened on shipboard at Colon and spent some weeks in investigations and in examining witnesses very much in detail, and in the case of myself, uncomfortably close to the third

degree. As I had been on the ground but a comparatively short time, by reason of the gigantic problem with its immense mass of details, many of my answers, naturally, were largely guesswork, yet I never wavered in advocating the lock type later described. A majority of the board, all of the foreign members and two of the Americans, voted for a so-called sea-level canal. The remaining two Americans made a minority report in favor of a lock type, with a summit level of 85 ft. above mean tide. Thus the momentous issue was put up, in its finality, to the President and Congress.

The kind of a canal advocated by the majority report of the board was an impracticable futility; it would have been a narrow tortuous ditch, only 150 ft. in width, with jagged rock sides, and only a crude plan for controlling the waters of the Chagres River, which in floods quickly varies from 750 to 140,000 cu.ft. per sec., with 38 torrential streams pouring directly into the proposed canal, bringing detritus of all kinds, gravel, rocks and timber. It would have required the entire capacity of such a ditch to move the many tugs, dredges and cranes back and forth that would be necessary to keep it open, regardless of commercial or naval passages.

The board's proposed plan to curb the floodwaters of the Chagres River was not based, as far as I could ascertain, upon any definite knowledge of the suitability of the suggested site for the construction and stability of a high dam. The method of disposing of the floodwaters without their seriously affecting the passage of ships along the sailing channel of the canal was entirely theoretical, as was the proposed method of carrying them to the ocean. Regardless of these considerations, the dimensions, alignment and general character of the waterway as recommended by the international consulting board of engineers were sufficient in themselves to condemn it, in my judgment.

Foreseeing what I feared would be a very strong concerted drive on the part of the one-idea sea-level advocates to force that type to adoption, under date of Dec. 19, 1905, before the international board of engineers had been convoked, I addressed a long report to the Isthmian Canal Commission, setting forth my views as far as I had then been able to formulate them from the data that I had gathered and classified in a few months. In it I elaborated at some length upon the two types, holding that under the conditions which existed the construction of a real sea-level canal was not practicable. Instead I recommended:

A high-level canal, with an earth dam at Gatun to carry a head of 75 or 80 ft. of water, this height to be overcome by a double flight of locks of 37½- or 40-ft. lift each; this level to continue to the vicinity of Pedro Miguel; there by similar double-lift locks to drop to sea level on the Pacific Ocean, with a tide-regulating lock in the neighborhood of Miraflores.

The report of the two American engineers who constituted the minority in the international board of engineers was made much later than the one from which I have just quoted. It recommended the adoption of a plan for an 85-ft. high-level canal, the one that was built and has been in successful operation for nearly twenty years. It will be noted that at least one other American engineer had already recorded the same opinion, and he heartily indorsed the minority report.

My final report in regard to type was made to the Isthmian Canal Commission, and after details, read as follows:

The sum of my conclusions is, therefore, that, all things considered, the lock type or high-level canal is preferable to the sea-level type, so called, for the following reasons: It will provide a safer and quicker passage for ships, and therefore will be of greater capacity. It will provide, beyond question, the best solution of the vital problem of how safely to care for the floodwaters of the Chagres and other streams. Provision is made for enlarging its capacity to almost any extent at very less expense in time and money than can be provided by any sea-level plan. Its cost of operation maintenance and fixed charges will be much less than any sea-level canal.

The time and cost of its construction will not be more than one-half that of a canal of the sea-level type.

The element of time might become, in case of war, actual or threatened, one of such importance that measured not by years, but by months or even days, the entire cost of the canal would seem trivial in comparison.

Finally, even at the same cost in time and money for each type, I would favor the adoption of the high-level lock plant, in preference to that of [note the underscore] the proposed sea-level canal. I therefore recommend the adoption of the plan for an 85-ft., summit-level, lock canal, as set forth in the minority report of the consulting board of engineers.

The Isthmian Canal Commission accepted my report, paraphrased it with additional arguments, and sent its report to President Roosevelt, as strongly advocating the lock type.

I thought at that time that the presidential mind rather inclined to a sea-level canal, but not the kind that the majority of the board of engineers advocated, but I found that he was still open to conviction. I labored with both him and Secretary Taft, and believed then, as I have ever since, that my labors were not wholly in vain. The President recommended the lock type to Congress.

Before the Senate committee for two blistering hot days I withstood severe, though always courteous, questioning. Collectively and individually, I argued for the lock type. There never was any doubt whatever as to the result of a vote in the House, but there was grave doubt as to what action the Senate would take. Senator Knox was in charge of the matter, and he handled it in a masterly and dramatic manner on the floor of the Senate, but I may say that much of his speech, which undoubtedly made a majority vote possible, was read from typewritten sheets dictated by myself. The majority vote of the Senate was small (seven as I recall), but it was enough.

To revert to the examinations made by the Senate committee: One senator asked me (off the record) if I seriously meant to tell the senators that an earth dam 100 ft. high, would hold back a lake 30 miles long. He said that he could believe it would do so in the case of a small lake, etc. I replied, "Well, senator, the earthen dikes of Holland hold back the Atlantic Ocean." The senator's education in the principles of hydrostatics had evidently been limited. His question illustrates some of the objections that had to be overcome.

The late Senator John T. Morgan, who was a strong advocate of a canal at Nicaragua and who opposed any canal at Panama, was the most persistent and intelligent of my questioners, and showed the widest grasp of the subject. At the close of the hearing he came to me and said, "If we had you on our side, the canal would be built at Nicaragua." As he was one of the most conscientious of men and had for years studied the canal question, I took his remark as a great compliment.

The key to the problem of building a canal at Panama was the adoption of the concept of an earth dam at Gatun. This dam answered correctly the all-important question of how the turbulent Chagres River could be controlled and made the servant, instead of the master, of the situation. With few exceptions, like the Culebra Cut, all other problems were matters of detail, immense in number, variety and size, but easily solvable. The dam is the key to the arch of the whole gigantic creation.

It may be accepted as axiomatic that an earth dam with a suitable foundation, properly designed, of a size to insure ample weight, with abundant allowance for line of saturation, built of clayey material mixed with a small proportion of sand, solidified by hydraulic pumping, thoroughly riprapped against wave wash, is the safest dam that can be built within economic limits of cost of construction, provided that its spillway is made secure against the erosion of fast-flowing water and is of sufficient capacity to carry the waters of the greatest flood that can possibly occur. Gatun Dam amply meets every one of these requirements.

Without exception every one of our engineers who had been some considerable time on the Isthmus favored the high-level type and looked askance at the kind of a sea-level canal that was advocated. Credit was given them for their accurate judgment.

The correct decision as to type, great resources, sanitation, modern machinery and the indomitable American spirit were the factors which gave to the United States a successful Panama Canal. Those who took part in its creation can, and could during their lifetime, take a just pride in the great work which their minds and hands wrought.

Suspension-Bridge Towers Erected with Guy Derrick

Supported on a light steel staging on the center line of the bridge, a 75-ton-capacity guy derrick proved unusually effective in erecting structural-steel towers 270 ft. high and 98 ft. wide for the 1,380-ft.-span Triborough suspension bridge at New York

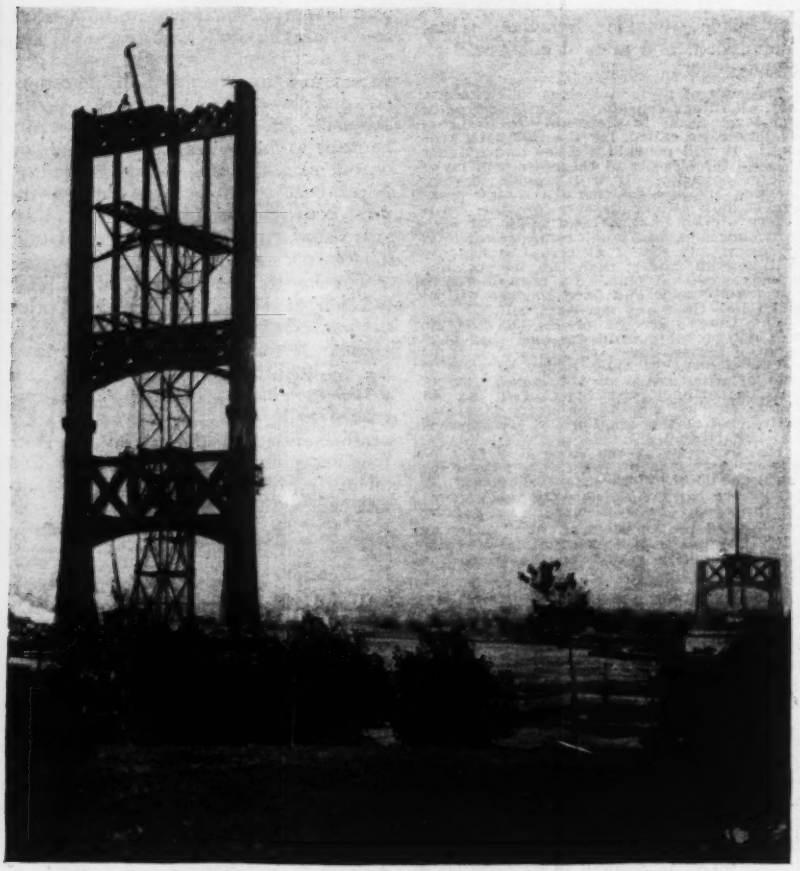


FIG. 1—GUY DERRICK preparing to top out the Queens tower of the Triborough Bridge. Across the East River, 1,380 ft., the Ward's Island tower is up to roadway level.

A DEPARTURE from usual practice in suspension-bridge tower erection characterized the work on the Triborough Bridge over the East River between Queens and Ward's Island in New York City. By using a guy derrick set on structural-steel staging in the form of a 20-ft.-square tower resting on the pier between the bridge tower legs, and progressively built up as erection continued, both safety and efficiency were secured. Although exceptional speed was not necessary on this job, cable spinning not being scheduled until eight months after tower erection began, this erection scheme, nevertheless, demonstrated that it could be geared to a speedy program. For example, the best day's work was the erecting in eight hours of eight pieces, comprising 79 ft. of one leg of the Ward's Island tower; the entire 1,500 tons of steel above the roadway level in this tower was set in 30 days. In addition to erecting the two 3,000-ton main towers, the guy derricks were also used on the two 600-ton cable bent towers. All holes were drilled in the shop, the fabricator electing to use this method over punching, which was permissible on the thinner plates.

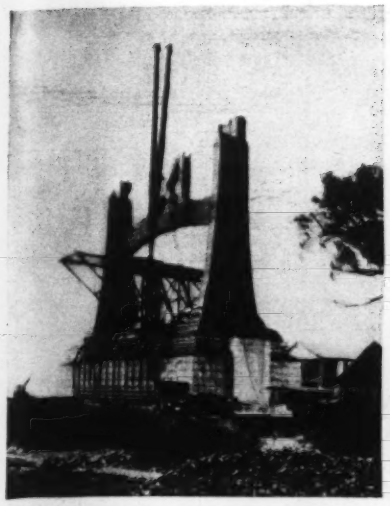
Choice of method

The evolution of the planning which produced the unique method of erection finally used is interesting. As noted in the previous article (*ENR*, Aug. 7, 1935, p. 177) the original design for the Triborough suspension span, and the one upon which the contract actually was awarded, utilized a four-leg tower, with the two center legs set close together. In considering means for erecting such towers, the contractor studied the conventional creeper that has been used on numerous suspension bridges. There seemed to be several objections to its use: two creepers would probably be required, one for each pair of legs; to support the creepers adequately, field holes would have to be 100 per cent bolted; and finally the creeper might set up torsional stresses in the tower that would produce distortions. The last consideration seemed unusually important on this job because the contract agreement stipulated that after a certain height of tower had been erected, all work was to be stopped, including fabrication, and any necessary adjustments in the details were to be made. Distortions thus were to be avoided and, in casting about for a method, a guy-derrick scheme was chosen because of the relatively light weight of the equipment required.

As first contemplated for the original tower design, the guy derrick was to be carried between the two inside legs on short beams spanning between them. When, however, the revised tower design eliminated the two inside legs, this simple and acceptable method could not be used. The next and final step in the evolution was to provide a temporary falsework tower, to take the place of the discarded permanent tower members as a support for the guy derrick.

General plan

The contract involved the erection of a 270-ft.-high tower and a cable bent, both 98 ft. wide, on both the Queens and Ward's Island sides of the river. Work began on the Queens tower, but the procedure did not involve erection of one tower complete before going to the second. Instead, after the Queens tower had been erected to roadway level, the erecting derrick was taken down and transferred across the river to the Ward's Island tower, which was then erected to the same height. In the meantime, the Queens tower steel had been riveted. The derrick was then returned to Queens, where it completed the tower while the Ward's Island tower steel was being riveted. The derrick then was returned to Ward's Island, where it completed the tower and later the cable bent. Finally the derrick was brought back to Queens, to erect the cable bent on that side of the river. By this sequence, in which raising and riveting were completely separated, riveters were never endangered by having erection operations going on above them. Also, a series of operations on one tower was immediately fol-



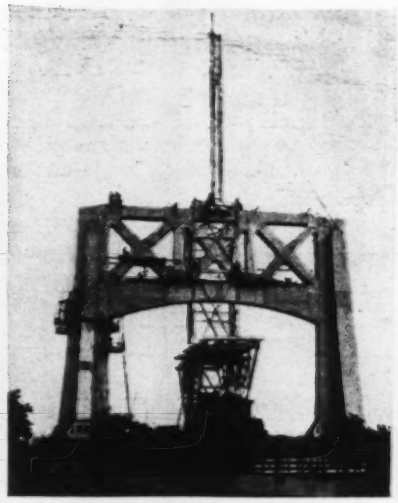


FIG. 2—BEFORE AND AFTER the first jump of the guy derrick. Guys connect to outriggers on the staging tower and to the legs of the bridge tower. The heaviest erection piece was a 50-ton lower section of the leg. The largest erection piece was the bottom chord of the truss, 96 ft. long and weighing 45 tons.

lowed by exactly the same operations on the other tower, and this had the effect of increasing the efficiency of the men on the repeated set of operations. This increase in efficiency was proved beyond question, in the opinion of the contractor.

Erecting equipment

The staging tower was made up in panels from 30 to 33 ft. high. In plan, the tower was 17 ft. 8 in. x 19 ft. 6 in., the latter dimension being parallel to the bridge center line. The four legs were 10-in., 49-lb. H-sections, which were attached to the pier by the anchorbolts that had been placed for the center legs of the original bridge tower. In the strongest direction, parallel to the bridge center line, struts and diagonal bracing were wide-flanged steel sections, generally 10-in., 23-lb. size; on the front and back faces of the towers, two angles (5x3½x½ in.) constituted the struts and bracing. Panels were interchangeable and joints were bolted. Although designed to be self-supporting under vertical reactions as great as 165 tons and horizontal thrusts of 25 tons, the top of this erecting tower at each successive lift was guyed to the steel of the bridge tower for additional lateral stability. At all except the highest position of the staging tower (El. 247) the guys were in the form of wire cables, but at the latter position, halfway between the top and intermediate truss of the bridge tower, a more substantial bracing was deemed necessary. Accordingly, horizontal trusses were inserted between the top of the staging tower and the bridge tower legs.

The platform for the guy derrick at the top of the staging embraced outrigger trusses, for guy fastening, extending 38 ft. front and rear. The platform itself consisted of 30-in., 115-lb. H-beams spanning between the front and rear staging tower legs and supporting, in a transverse direction, two other beams of the same size but strengthened by two 12¼-in. coverplates. These latter beams carried the heavy timber blocks to which the foot of the derrick was fastened. The staging tower was so located that the erecting derrick was 9 ft. in front of the transverse center line of the bridge tower, thus clearing the bracing trusses.

The erecting derrick, which weighed 35 tons, had a capacity of 75 tons, a 94-ft. boom and a 106-ft. mast. Tackle consisted of a 13-part wire-rope falls and a 9-part topping lift. The derrick was operated by a three-drum steam hoist supported at pier-top level. Steam was used because at the start of the work the utility company asked too high a price to bring an electric line to the work. Later this price was reduced, and electricity was used for the compressors and for an unloading derrick

FIG. 3—ERECTION PLAN and equipment used for towers of the Triborough suspension bridge in New York.

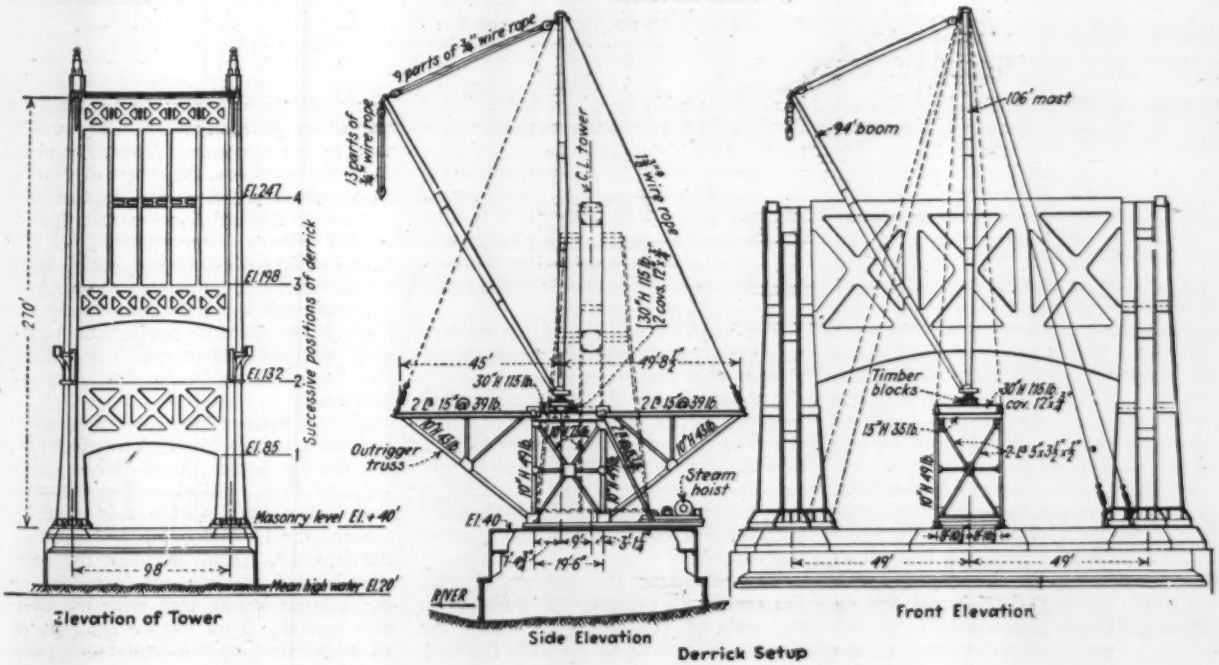


FIG. 4—FABRICATING-SHOP views of Triborough Bridge tower members. The bracket shown at the top of the truss is the connection for the lateral floor bracing; the bracket on the side of the tower-leg section is the stiffening-truss rocker arm.

on Ward's Island. A 15-ton auxiliary derrick with 88-ft. boom was used to erect the first lift of the staging tower and to assemble the erecting derrick in place. It was also used to remove the erecting derrick and, finally upon completion of the work, to set equipment on top of the towers for the later use of the cable-spinning contractor.

The mast of the derrick was guyed front and rear with two 1¾-in.diameter wire-rope cables extending down to the ends of the outrigger trusses; similar-size guys in a transverse direction were attached to the legs of the bridge tower.

Erection procedure

In erecting the main towers, derrick settings at four levels were utilized. From the first setting at about El. 85 (pier-top level being at El. 40) the shoes and all steel up to and including the cross-truss that supported the roadway at El. 132 was set. The staging was then built up to El. 132, and steel was set to El. 198, the top of the portal truss. The third setting of the derrick was at El. 198, and the last at El. 247, from where the tower was topped out. The staging tower was built up as required by the erecting derrick. In jumping the derrick from one level to another, the procedure ordinarily used in building practice was reversed—that is, the boom was lifted first and the mast followed. This was necessary because the jumps were from 50 to 65 ft. each, and for such a lift the boom was too limber to handle the mast; in building work the jumps are seldom over two stories, at most 30 ft.

For the Queens tower and cable bent, steel was received by truck from railroad yards about 3 miles distant, while the Ward's Island steel was brought to the site on car floats and unloaded with a 75-ton stiff-leg derrick set up on shore. Erection pieces were large and heavy. The heaviest occurred at the base of the cable bent legs and weighed 62 tons. In the main towers the heaviest piece was a 50-ton leg section, although the bottom chord of the roadway truss not only weighed nearly 45 tons but in addition was 96 ft. long. All bottom chords were erected in one piece, while the top chords were spliced at the center. The ends of the chords at the splice were milled for bearing.

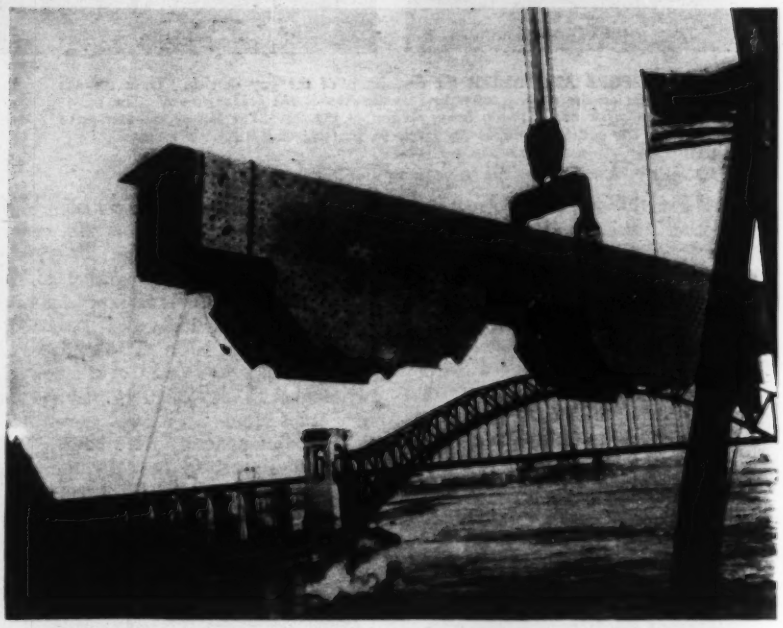


FIG. 5—LIFTING LAST MEMBER in Queens tower with the special balance beam and hitch plates. Hell Gate railroad bridge is in background.

The handling of these heavy sections was greatly facilitated by using special plate hitches that were attached to each shipping piece in the shop, accurately located over the center of gravity of the member, so that it would balance in a horizontal position when it was picked up, loaded on freight cars, unloaded to trucks or to storage, and finally handled into position within reach of the erecting derrick.

The fabricator also cooperated with the erector in locating the position on the ends of the pieces to which the hitches should be transferred in the field, to permit the members to be lifted in the exact position which they would take in the structure. Thus, for main tower leg members, the center of gravity in up-ended position was located and accurately marked for the information of the erection superintendent. Likewise for the cable-bent legs, which were set inclined, and for truss web members a point was marked over which the hitch plates could be applied, to assure that the member would hang from the derrick lines in its final inclined position.

Special balance beams were designed to attach to the hitch plates and take the derrick hook. These beams were supplied to the railroads for use with their cranes, and to the field superintendent for his unloading and erecting derricks. A special detail in the form of a slotted pin hole was provided on the balance beams used with the erection derrick. This was for the purpose of adjustment of the load application.

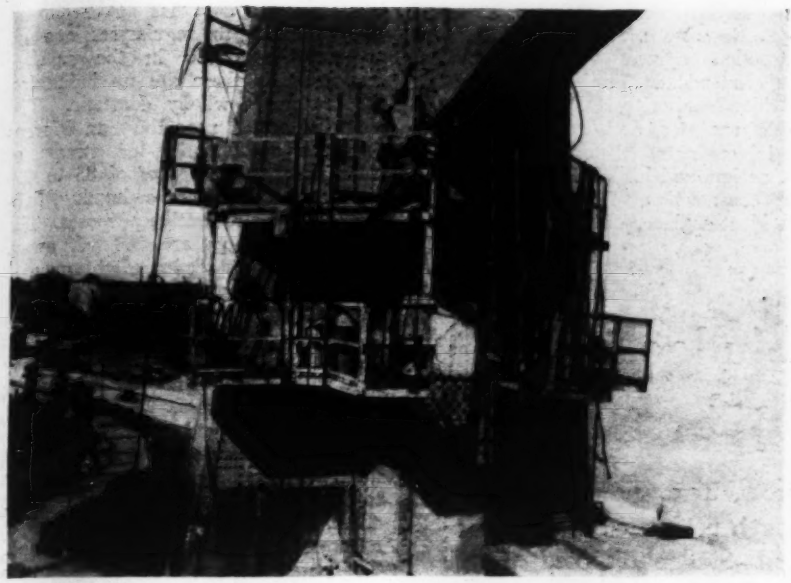


FIG. 6—RIVETING CAGES built to fit the outline of the tower legs and operated by conventional building scaffold hoists. The two-story design was liked by the riveters.

in a direction perpendicular to the hitches, on unsymmetrical members whose center of gravity in an up-ended position was not in the exact center of the member. In so far as erection sequence of the shop-fabricated pieces was concerned, operations followed usual practice.

Special two-story riveting cages were used, four cages to each tower leg. The cages were L-shaped, to fit the tower legs and, by the use of planks connecting the several cages, a walkway entirely around the tower legs was provided. The "second story" of the riveting cages was actually intended as a roof, to protect the riveters and heaters from falling objects. However, when it was decided to eliminate all erecting operations above the riveters, this danger was removed. Actual riveting operations with the cages brought out the riveter's preference for the two-story idea and, for the most part, the rivet forges were placed on the lower level, with riveting operations carried on from the upper level. (For the inside rivets, the forges were set up in the center compartment of the tower leg.) The two-story scaffolding arrangement also contributed to efficiency, for when one riveting gang completed its work ahead of another, it could raise its cage until its lower level coincided with the upper level of the other cages. Thus a connection was maintained with all cages around the tower even though one gang was ahead of the other. The cages provided a walkway 3½ ft. wide and a ceiling height for the lower story of about 8 ft. They were raised with ordinary building-scaffold hoists operated by the riveters themselves.

The cable bents resting on the toe of the anchorage blocks consist of two legs 98 ft. apart and tilted away from the main span at an angle of about 25 deg.; heavy strut bracing is used between the legs. For erecting these bents, the 75-ton derrick was set up on a two-panel length of the staging tower, which was placed over the existing anchorbolts on the center line of the bridge. Each leg contained six erection pieces, including the 10-ton saddle. The heaviest piece was the lower leg section, which weighed 62 tons.

The base casting weighed 58 tons and had to be set very accurately. This was accomplished by first placing 12-in.-square plates over the anchorbolts at the four corners and grouting these to the plane of the bottom of the base casting. It was then possible to set the casting on these plates at the correct location, with certainty that it was also correct as to elevation and slope. Grouting under the whole area of the casting then followed.

With the base castings set, it was next necessary to erect a temporary framework as a support for the inclined cable bent, which otherwise would be held only by its anchorbolts until the load from the cables was applied. Erection of the cable-bent members then followed in rapid succession, since there were no vertical field splices to be

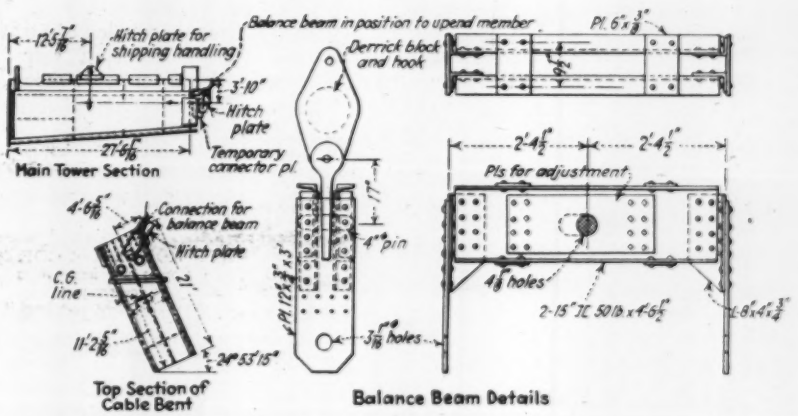


FIG. 7—BALANCE BEAM for derrick hook and examples of hitch-plate connections located in shop, to assure that members would hang from the derrick falls in exact position for easy handling and erection.

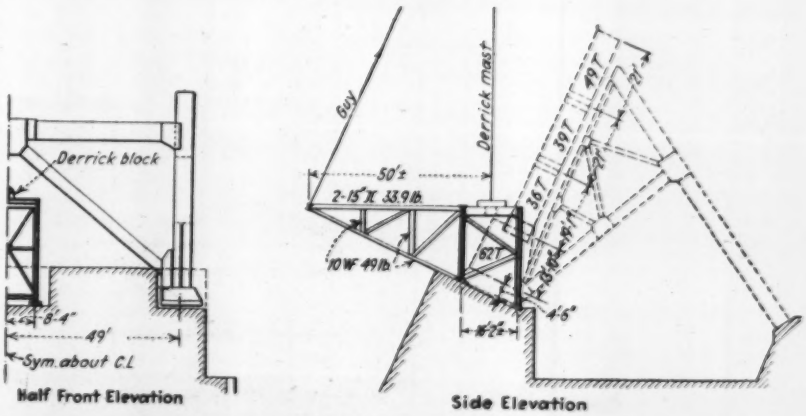


FIG. 8—ERECTION SCHEME for cable bents also involved the use of guy derricks. The heaviest pieces, 58 and 62 tons respectively, occurred in these cable bents.

bothered with as there were on the main towers. The final operation was to induce a normal stress condition in the bents by jacking a calculated reaction of 37 tons per leg at the top of the falsework. Any variation between the resulting inclination and the theoretical inclination was neglected.

Tower and cable-bent erection on the Triborough Bridge was carried out by the Taylor-Fichter Steel Construction Co., New York, H. O. Adelman, construction engineer and John Grandin, superintendent. For the Triborough Bridge Authority, O. H. Ammann is chief engineer, E. W. Stearns assistant chief engineer, Allston Dana engineer of design, and H. W. Hudson, engineer of construction. Homer R. Seely is resident engineer on this section.

Pioneer Activated-Sludge Plant Still in Service

Nineteen-year-old unit at San Marcos, Tex., produces good effluent with air delivered through perforated pipe system after diffusion plates clogged—Sludge disposed of by irrigation on same land throughout life of plant

By E. W. Steel
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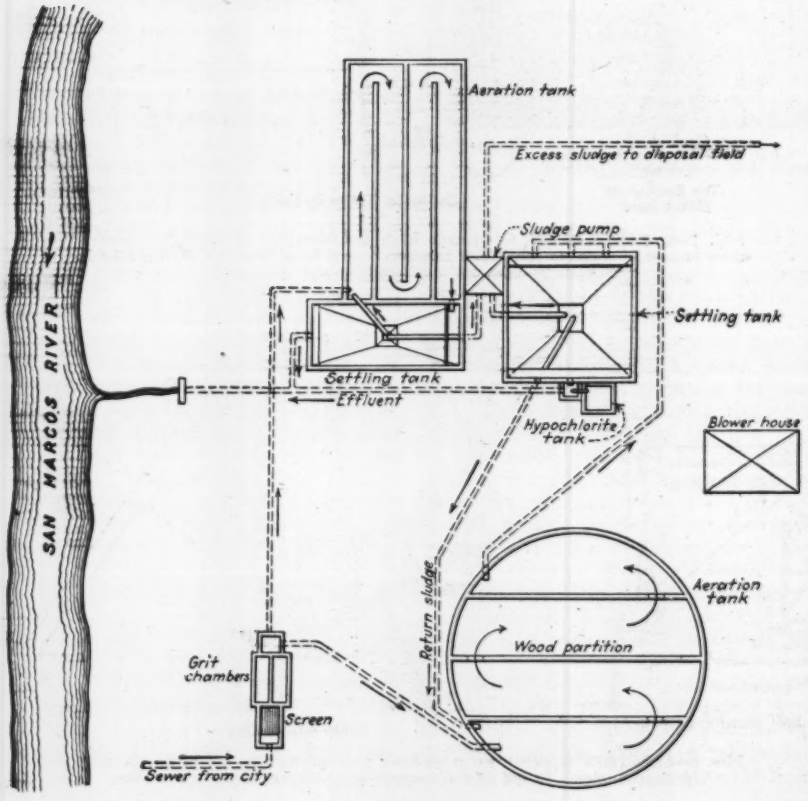
ALTHOUGH a few experimental activated-sludge units had been constructed before the plant at San Marcos, Tex., was built, this small city can boast that it still, after nineteen years, operates the first plant of this type which served an entire city. The changes that have been made since 1916 to meet varying conditions, as well as the method of sludge disposal, make the plant an interesting one.

San Marcos had a population of 5,034 in 1930, nearly all of which was served by the sewers. A state normal school, located in the city, has an enrollment of 1,500 during the regular sessions and as many as 2,000 in the summer sessions. As there are no industries, the sewage is wholly domestic. The plant is located near the San Marcos River, a swift spring-fed stream of clear water, with a flow of 83 to 150 sec.-ft., much used for swimming, fishing and other recreative purposes. The nearest residences are 100 yd. away, and the business section of the town is ¼ mile from the plant. Grades are good in most of the sewers, and the sewage is fresh when it reaches the plant. The present average flow is 300,000 gal. per day, with a peak flow rate of 435,000 gal. per day at 8 a.m. Water pumpage averages 375,000 gal. per day.

FIG. 1—PLANT LAYOUT of old San Marcos activated-sludge sewage-treatment works, the first complete installation of this type in this country.



In 1907 the sewer system was built under a franchise granted by the city to a private company. A circular tank 40 ft. in diameter was constructed as a combination sump and settling tank. The sewage was pumped from the tank to near-by land at intervals throughout the day. The tank is still doing duty but is now used as an aerating unit.

Late in 1915 or early in 1916 (the exact date is not obtainable from the Texas State Health Department records) Ashley Wilson, one of the engineers of the Texas Sewer Co., which had acquired the franchise, constructed an activated-sludge plant, consisting of a rectangular aeration tank, with foot-square filtros plates and a hopper-bottomed rectangular tank for final settling. There was no presettlement of the sewage. The excess activated sludge was and still is disposed of by irrigation on the land that had formerly received the settled sewage.

The new plant, the first activated-sludge plant to serve a city, was successful. Sludge bulking occasionally occurred and, in the effort to overcome possible ill effects upon the San Marcos River, a gravel filter bed was constructed, to give a further treatment to the turbid effluent then produced. This experiment was of such doubtful success that it was abandoned. Occasional complaints were received by the state health department, but these came in the main from persons who wished to open bathing beaches in the river below the plant, and were not based upon any evidences of pollution occurring in the river.

As the sewage flow increased, an enlargement of plant capacity was attempted by using the old circular sump as a presettling tank. It was too large for this purpose; the sewage became septic and the final results were poor. In 1925, when the flow was something over 200,000 gal. per day, the plant was enlarged by changing the old circular sump into an aeration tank. Wooden partitions were installed, and air was applied through the open ends of small pipes. Additional final settling capacity was obtained by constructing another sedimentation tank. Still later a bar screen and grit chamber were installed.

and chlorination with high-strength hypochlorite of lime is now practiced as a routine measure.

Fig. 1 is the plant layout for the treatment works. As nearly as possible, one-third of the sewage, after screening and grit removal, is sent to the rectangular aeration tank and two-thirds to the circular tank. Aeration was formerly applied in the rectangular tank by means of filtros plates 1 ft. square, located 7.5 ft. below the sewage surface, one plate being placed at the bottom of each hopper. The plates clogged after years of use, and aeration is accomplished at present by means of an open-ended pipe discharging air just above each filtros plate. There are thirteen hoppers in each channel, making a total of 52 hoppers and the same number of open-end air pipes. The aeration period in this tank is 7.5 hours. A recent analysis of the sewage-sludge mixture after settling 30 min. showed 250 c.c. of brownish gray sludge per liter of sample.

The circular aeration tank is 40 ft. in diameter and has a sewage depth of 9 ft. The aeration period is 10 hours. Air is applied through ½-in. open-end galvanized pipes, 173 in number on 2.5-ft. centers each way. The air escapes 8.5 ft. below the sewage surface. Perforated caps on the ends were first tried, but these soon clogged. Horizontal tees were also tried, but it was found that all the air escaped from one end of the tee. The flow of air is now equalized by means of orifices that have been inserted in unions on each vertical supply pipe. There are no valves. As sand tended to accumulate on the flat bottom of this tank, a grit chamber was constructed. The mixed liquor showed 125 c.c. of sludge per liter after 30-min. settling. It was gray in color except for the large particles.

The settling tank that receives the mixed liquor from the rectangular aeration tank is 10x24 ft. in plan and 21 ft. deep to the bottom of its single hopper. It provides a theoretical retention period of 4.7 hours. The other settling tank is 20 ft. square, 21 ft. deep to the bottom of the hopper, and has a theoretical retention period of 3 hrs.

Returned sludge is pumped from the settling tanks to the aeration tanks by air lift. When necessary, excess sludge is pumped to land, where it is disposed of by irrigation. The plant site includes 15 acres, of which 9 acres are farmed and 6 acres are used for sludge disposal. Header ditches discharge the sludge into long furrows. By careful operation, especially rotation in sludge application and frequent plowing, nuisance has been avoided, and the same land has been used for many years. Some stock feed is raised on the farm, but little attempt is made to produce anything on the sludge-irrigated soil. The sludge is applied intermittently to the soil, which is now showing the results of long use. It is full of organic matter, and worms of various kinds are abundant. Flowers have been planted freely at conspicuous points to make the plant site and farm attractive.

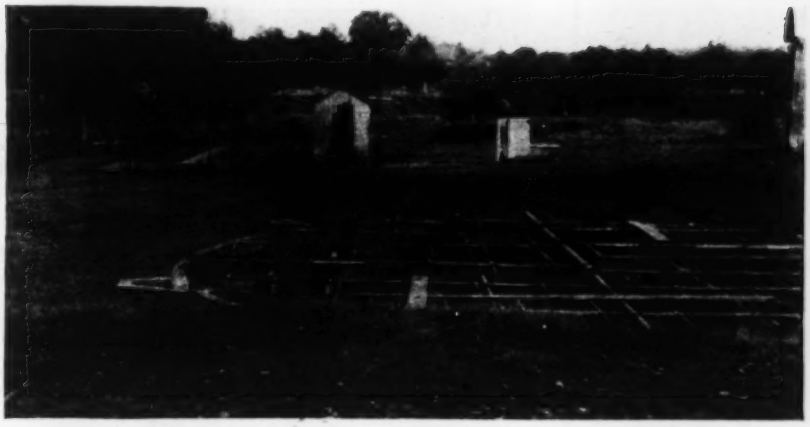


FIG. 2—CIRCULAR AND RECTANGULAR aerating tanks at San Marcos plant receive air through a header-pipe system on top of the tanks.

The plant effluent is good. An analysis made on an 11 a.m. sample collected recently was as follows:

	Influent	Effluent
pH	7.3	7.6
B.O.D., p.p.m.	140	15
Susp. solids, p.p.m.	146	14
Ash, per cent	18.9	27.8
Free NH_3, p.p.m.	20.0	7.0
Nitrites, p.p.m.	....	0.1
Nitrates, p.p.m.	1.4	2.4

This effluent is obtained with a considerable air consumption. Two blowers are used, one furnishing 443,000 cu.ft. per day to the circular tank, or 2.22 cu.ft. per gal., and the other supplying the rectangular tank with 343,000 cu.ft. per day, or 3.43 cu.ft. per gallon. For the whole plant the air consumption is 2.93 cu.ft. per gallon.

The operating costs include the following items: power, $140 to $150 per month; labor, one man on farm at $3.50 per day; one man, general labor, $1.75 per day; hypochlorite 16 lb. per day. The total monthly operating cost is about $330 per month, or $36.67 per million gallons treated. On the credit side there is a return for stock feed used by city teams, which the water superintendent estimates offsets much of the time of the higher-priced laborer. If his time is disregarded, the cost will be about $27 per million gallons treated. On the other hand, no charge has been made for supervision, which is exercised by M. M. Joiner, the waterworks superintendent.

The future of this old-timer among activated-sludge plants is doubtful. Due to high cost of operation, plans were made two years ago for a new plant of the Imhoff tank and trickling-filter type to be located 2 miles downstream. This was to have been a PWA project but was never started.

PWA Report Indicates Scope of Work

A REPORT to Administrator Ickes on July 29 showed that PWA has under construction more than 4,500 federal and non-federal projects costing nearly $1,800,000,000. The report of the PWA Division of Economics, which has just completed a national survey of the public-works program, indicated that 13,238 projects, costing $685,421,693, have been completed and are in use. At present 4,514 projects, costing $1,787,187,135, are under construction, and 1,426 projects costing $321,026,225 have received allotments and are in various stages of progress preliminary to actual construction.

Prior to July 1, PWA spent $1,550,000,000 almost entirely as wages, which does not include such executive and special allotments as: $400,000,000 to CWA, $323,362,000 to CCC, $262,000,000 to FERA, and $100,000,000 to FCA. Of the $1,550,000,000 indicated as having been expended for wages, $1,000,000,000 went for material and provided secondary employment. Wages totaling $485,000,000 were paid on construction sites of PWA projects, while $65,000,000 was spent largely as wages for those employed in other phases of the program.

PWA has under construction 1,555 non-federal projects, the estimated cost of which is $729,802,193. These do not include federal housing projects but are of the type for which PWA is now receiving applications for loans and grants. At present 2,130 applications amounting to $501,114,249 have been reported.

The number of PWA applications received in Washington has shown a marked increase in the past week as the state offices, under the recently decentralized PWA examination procedure, act upon requests of communities.

Sewage-Treatment Facilities in the United States

A Survey by Engineering News-Record

LESS THAN one-third of the urban population of the country is served by sewage-treatment plants, a nationwide survey of sewage-disposal facilities by *Engineering News-Record* shows. Data provided by state sanitary engineers reveal that the population served by public water supplies totals 76,714,000, and that 80 per cent of this total is served by sanitary sewers. Sewage-treatment plants totaling 3,697 serve about 22,200,000 persons. These figures and many more detailed data in regard to sewage disposal in the United States are shown in the tabulation on the accompanying insert.

It will be noted that in the 44 states reporting, there are 3,471 communities served by treatment plants, while the number of treatment plants serving these communities totals 3,697. The difference between these two figures is occasioned by the fact that a number of cities are served by several plants. On the other hand, there are also some communities that share a sewage-treatment plant with a neighboring town.

Illinois leads the list of states in the total number of population served by sewage-treatment plants, caring for 3,849,000 in this way. Arranged in the order of population served, the first eight states are as follows:

Illinois	3,849,000
Ohio	2,688,860
California	2,522,000
New York	2,345,639
Texas	2,300,000
New Jersey	2,119,083
Maryland	915,000
Oklahoma	773,784

With regard to the number of communities served by treatment plants, however, the lead is taken by Texas, which includes within its borders 371 such plants. States having 100 or more treatment plants are shown in the following tabulation, arranged in the order of the number of plants in the state. The numbers in parentheses are the total number of plants reported in a similar but less complete survey made in 1929. California, both in number of new plants built in the last five years and in per cent increase, leads all the other states.

Texas	371	(298)	Oklahoma	157	(134)
Calif.	253	(114)	Kansas	131	(110)
Iowa	228	(212)	Wisconsin	120	(100)
New York	219	(127)	Ohio	113	(89)
Pa.	201		Minnesota	107	(106)
New Jersey	189		N. Carolina	100	(92)
Illinois	178	(159)			

Perhaps a more appropriate measure of the adequacy of the sanitary facilities is given by the proportion of the population served by sanitary sewers that is also served by sewage-treatment plants. When measured in this way, Texas again takes the lead, for 2,300,000 or 87 per cent of the 2,657,460 population served by sanitary sewers in Texas are also served by treatment plants. Illinois, which includes the large Sanitary District of Chicago installation that serves practically the entire population of Chicago, is a close second with 85 per cent. The first eight states when listed in this manner are as follows:

	Per Cent		Per Cent
Texas	87	Oklahoma	79
Illinois	85	New Mexico	75
Maryland	83	California	74
Rhode Island	83	Arizona	74

It is noteworthy that altogether 61 per cent of the communities boasting sanitary-sewer systems also provide sewage-treatment facilities, while but 36 per cent of the sewered population is so served. From this it can be concluded that the small communities are more adequately served by sewage-treatment plants than are the larger cities.

A measure of the amount of purification provided in a particular state may be obtained by the data reported on degree of treatment. Thus, it is evident that the majority of the sewage plants in existence today do not carry treatment beyond primary sedimentation. In this connection the heading "Oxidizing Process" includes such plant units as trickling filters, aeration tanks in the activated-sludge process, and intermittent sand filters.

An analysis of the type of processes and sewage-treatment units employed in the 3,697 plants covered is given in that part of the table included under the head "Major Units of Treatment Works." It will be seen that a major portion of the primary treatment given is through the use of Imhoff tanks and septic tanks. (This, also, checks the conditions found in the 1929 survey.) Together, these two processes represent more than 3,000 of the plants listed. It should be remembered, however, that these data cover all the plants now in existence and make no effort to evaluate the trend of modern practice.

Among the oxidizing, or secondary treatment processes, the trickling-filter and intermittent fine-grain filter still dominate. Among the plants using the activated-sludge process, aeration by means of diffused air is employed more frequently than is mechanical aeration. As between 1929 and 1935, the number of activated-sludge plants in representative states is as follows: California, 5 and 12; Illinois, 7 and 11; Kansas, 3 and 9; Kentucky, 0 and 3; Nebraska, 0 and 3; New Jersey, 1 and 5; New York, 1 and 4; North Carolina, 2 and 4; Ohio, 3 and 5; Oklahoma, 1 and 4; Texas, 12 and 21; and Wisconsin, 0 and 4.

Open sand-bed drying is also far in the lead as the existing method of disposing of sludge. Mechanical dewatering, the process now so highly favored, has been introduced in only nineteen installations to date.

The collection and utilization of digested gas are employed in a surprisingly large number of installations—280 plants for collection and 164 for utilization.

It will be noted that there are some items in the table in which a zero is entered, while others are left blank. This should be interpreted to mean in the case of the zero that the state department of health has reported definitely that the item does not appear in that state, and where the blank is shown it means that no information is available on the subject.

INVENTORY OF SEWAGE

IN THE UNITED STA

State	Year of Data	Incorporated Places	Sanitary Districts	Population: Total Urban, 1930 Census Except as Noted	Population: Included in Sanitary Districts	Population: Served by Public Water Supplies	Population: Served by Sanitary Sewers	Population: Served by Sewage Treatment Plants	Sewers and Plants: Separate Sanitary Sewers	Sewers and Plants: Comb. San. and Storm Sewers	Sewers and Plants: Storm Sewers Only	Sewers and Plants: Communities Served by Treatment Plants	Sewers and Plants: Plants Serving These Communities	Degree of Treatment: Land Disposal	Degree of Treatment: Screening: Without Disinfection	Degree of Treatment: Screening: With Disinfection	Degree of Treatment: Primary Sedimentation: Without Disinfection	Degree of Treatment: Primary Sedimentation: With Disinfection	Degree of Treatment: Oxidizing Process: Without Disinfection	Degree of Treatment: Oxidizing Process: With Disinfection	Degree of Treatment: Secondary Sedimentation: Without Disinfection	Degree of Treatment: Secondary Sedimentation: With Disinfection	Plants Having: Pumps	Flow Meters	Coarse Screens	Grit Chambers	Fine Screens	Screenings Unwatering	Sedimentation Incinerators	Without Sludge Dem. Equip.	Plants Having: [illegible]
Ala.	34	297		744,273		970,195	557,553	287,985	128			52	52				46		4			2									
Ariz.	34	34	0	149,856		195,046	179,942	133,457	27			19	21	8[14]			18		1												
Ark.	34	384	0	382,878		447,583	430,734[7]	279,530[7]	79[7]	0	0	69[7]	69	0			52	3	2	1		0		9	0	0	0	0	0	0	0
Calif.	34	278	45	4,160,596	68,270	4,282,993	3,392,000	2,522,000[7]	332	19		253	218	13	25	0	126	7	34	0	38	21		69	8	29	3	11	1	2	8	
Colo.	34	241	0	579,882		1,090,000	999,577	47,823			0	20	21	0			13	1	3	2		1		3	1	1	0	0	0	0	
Conn.	33	41	1	1,131,770	1,300	1,500,000	1,124,000[7]	470,000	60	22		50	58	0	1	0	13	11	9	6	0	0		18	10	33	20	6	1	6	
Del.	34	47		153,384		160,722	135,386	13,000	10	6		6	5	0			2	1	2		2			2		3					
Fla.	34	289		759,778	500				107	1	0	77	86	0	1	2	66	4	0	0	0			2	0	3	0	1	0	1	
Ga.	34	563	0	895,492	0	1,130,000	798,000	332,000	<— 140 —>			46	43	0	0	0	41	1	4	0	0	0		0	2	6	3	0	0	2	0	
Idaho	34	150		129,507					64	3		19	17					4				2		3			2			0	
Ill.	34	1,129	24	6,282,166	4,545,126	5,896,255	5,822,813	3,849,000	162	180		178	196	0	0	0	74	7	31	1	58	7		29	40	65	43	0	3	12	
Ind.	34	523	1	1,795,892	364,161[5]	1,988,763	1,929,084	521,000	21	175	12	52[12]	52[12]	0	0	0	22		13[16]		3[16]			10	2	12	6	2	0	0	
Iowa	34	917	0	1,444,042[4]		1,367,237	1,247,989	484,854	<— 324 —>			228	264	3	0	0	41	0	152	1	34	2		21		16	15	0		1	
Kan.	34	580		729,834		969,397	885,950	547,500	<— 188 —>		0	131	135	0	1	0	41	0	76	0	30	0		12	8	25	2	0	0	1	
Ky.	34	370		700,000	0	1,000,000	750,000	160,000	75	15		29	33	0			17		6	1	1	3		3	1	18	18	0	0	1	3	
La.	34	210	1[1]	833,532		945,676	821,375	112,380				27	27				9		16	2				13	0		0	0	0	0	
Me.	34	48	1	821,506	6,000	386,000		8,500				6	6				6														
Md.	34	137	3	974,867	185,500	1,159,479	1,104,176	915,000	32	27		38	39	0		1	15	10	4	1	7	1		3	2	18	1	2	0	0	17	
Mass.	34	39	118	4,249,614	3,740,222	4,122,125		597,556[7]				35[7]	35	0					31		4			10	18	13	2	0	0	0	18	
Mich.	34	475	0	3,302,075	0	3,584,000	3,488,000	648,000	95	180		43	42	2		1	20	10	14		4	1		16	10	29	14	1		1		
Minn.	34	728	1	1,257,616	735,962	1,450,000	1,428,602[8]	234,042	<— 256 —>			107	110				80	7	2		17	1		15	6	4	0	3	0	3	3	
Miss.	34	313	0	338,850		474,429	387,840	63,472	85	0	0	43	43	0	0	0	35	3	0	0	0	3		7	0	4	2	0	0	0	
Mo.	34	773	0	1,859,119		2,048,977	1,800,000	295,000	69	71		79	95	0	0	0	53	3	21	2	5	2									
Mont.	34	116	0	181,036	0	245,000	241,033		<— 65 —>			36	36		0	0	35	1	0	0	0	0		4	0	6	0	0	0	0	3	
Neb.	35	529	1	743,400[4]	87,711	550,000	544,327		95			32	32				22		3		7									2	
Nev.		16																													
N. H.	34	11		273,079		334,091	81,000	14,000	23	38	3	8	8	0			7	1						0	0	2	0	0	0	0	0	
N. J.	34	329	1[2]	3,339,244	1,063,000	3,354,440	3,480,971	2,119,083	<— 227 —>		0	189	191	3	2	2	59	42	21	30	7	25			1[21]	1[21]	10				16[1]
N. M.	34	56	0	106,816	0	150,980	83,960[9]	63,460	33	0	5	28	26	11	0	0	25	1	1	1	0	0		7	0	13	2	0	0	0	11	
N. Y.	35	613	1	10,875,388	372,100	11,495,000	10,789,363	2,345,639	307	61		219	197	1	6	8	56	51	21	11	12	11					15	4	4	13	
N. C.	34	498	7	1,230,000	3,000	1,270,090	670,000	400,000	188	1	0	100	115	0	0	0	74	5	11	0	10	0		9	9	27	26	0			
N. D.	29	84		70,097					31	32																81		2			
Ohio	34	862	84[3]	4,989,999		4,770,181	4,500,000	2,688,860	178	65	68	113	136	0	1	1	23	17	63	8	20	3		23	46	96	26	2	1	6	14	
Okla.	34	512	0	821,681		1,061,984	983,324	773,784	191			157	170				86	6	53	12											1	
Ore.	34	204	0	587,096	0	584,000	540,000	84,000	44	46		40	61	0	0	0	36	1	1	0	1	1		4	1	7	3	0	0	0	6	
Pa.	31	985	0	6,533,511	0	8,000,000	5,500,000					201[19]	249	17	1	1	62	26	37	17	31	74				183	11	1				
R. I.	34	39		687,497			400,000[10]	330,000	8[7]	4[7]		8[7]	7	1			9[16]	3[16]	16[17]		1	1		7[20]	7	9[22]	3		1		2[23]
S. C.	34	265		521,323		402,205	336,553	108,309	<— 71 —>			37	38				33	1	3												1
S. D.	34	295	0	130,907	0	247,904	207,936	135,731	<— 92 —>			57	57	0			29	4	21		7				3	4		3	3	1	2	
Tenn.	34	233	0	896,538	0	1,014,900	635,000	130,000	84	3		46	77	0	0	0	38	1	7	0	0	0				0		0			
Tex.	34	580	3	2,389,348	50,000	3,000,000	2,657,460	2,300,000	380	0	150	371	390	50	2	1	150	15	110	85		25		100	50	250	150	5	0	200		
Utah.	32	143		266,264		379,000	262,900	34,500	37			17	17	4			15	2													
Vt.	34	75		118,766																											
Va.	34	187	4	902,548		1,000,000	880,000	63,700	153			44	53	0	0	0	14	10	7	3	5	5		4	2	9	1	0	0	0	0	
Wash.	34	221	0	884,539	0	800,000	744,000	62,200	58	59		33	37	0	1		20	4	2		1	4					1	0	1	3	
W. Va.	34	208	0	491,504	0	600,000		18,800				8	8	0	0	0	4	2			1	1		2	0	4	0	0	0	0	0	
Wis.	34	502	3	1,553,843	826,900	1,767,000			<—235[11]—>			120	125	0	0	0	83	2	14	0	26	0			10	57		1	0	3	15	
Wyo.		84																													
D. C.	34	1		500,000		500,000	500,000																								
Total...		15,995	299	72,604,000	12,049,003	76,714,000	61,338,300	22,200,000	3,125	976	238	3,471	3,697	213	41	17	1,670	267	816	184	142	199		410	329	1,032	460	69	11	233	159	
									<1,598[18]>																						
Located in No. of States			17	45		42	39	38	29	19	5	44	44	11	10	8	42	34	36	17	25	23		31	22	33	24	16	6	16	27	
									<— 9 —>																						

[1]Authorized development of New Orleans lakefront. District never organized.
[2]Passaic Valley Sewerage Commission, providing disposal for 21 communities.
[3]County sanitary districts.
[4]Includes all incorporated places.
[5]1930.
[6]Connected; accessible, 4,073,000.
[7]Municipal only.
[8]Total population of cities having sewers.
[9]Connected population.
[10]Newport and Jamestown not included.
[11]Includes 16 unincorporated places.
[12]Municipal, 38; industrial and institutional, 14.
[13]Includes municipal, real estate development, industrial and institutional.
[14]Discharged without treatment, 4; after treatment, 4.
[16]Industrial and institutional, 8; municipal, 1.
[16]Industrial and institutional, 1; municipal, 2.
[17]Industrial and institutional, 14; municipal, 2.
[18]Industrial and institutional, 5; municipal, 8.
[19]Industrial and institutional, 1; municipal, 2.
[20]Industrial and institutional, 1; municipal, 6.
[21]Passaic Valley Sewerage Commission system. Includes 42 flow meters, 15 coarse screens and 105 grit chambers.
[22]Industrial and institutional, 2; municipal, 7.
[23]Industrial and institutional plants only.
[24]One other plant uses coagulants part of the
[25]Industrial and institutional, 10; municipal
[26]Industrial and institutional, 3; municipal.
[27]Industrial and institutional, 4; municipal.
[28]Industrial and institutional, 11; municipal
[29]Industrial and institutional, 2; municipal.
[30]Industrial and institutional, 13; municipal
[31]Lagooning.

VAGE DISPOSAL

ED STATES

Major Units of Treatment Works
Number of Plants Using

Primary Sedimentation[39]								Filters			Activated Sludge				Disposal of Sludge									
Plain Sedimentation Tanks				With Sludge Rem. Equip.												Sand Beds					Gas			
Coarse Screens	Grit Chambers	Fine Screens	Screenings Dewatering	Screenings Incineration	Without Sludge Rem. Equip.	With Coag.	Without Coag.	Imhoff Tanks	Septic Tanks	Trickling	Contact Beds	Intermittent Fine Grained	Diffused Air	Mechanical Aeration	Secondary Settling	Chlorination	Separate Sludge Digestion	Open	Covered	Chemical Conditioning of Sludge	Mechanical Dewatering	Incineration	Collection	Utilization	Sludge Lagoons	State
2	2			1	0	1	1	5	45	1	2	1	<—2—>		2	2	2	2					2	2		Ala.
					0	0	1	3	14	1					2	1	2	4					1	1		Ariz.
12	4	0	0	0	16	0	1	40	13	2	9	2	0	0	0	4	6	6	0	0	0	0	0	1		Ark.
20	3	11	1	2	8	0	23	101	86	43	2	8	9	3	46	30	36	104	1	1	1	0	14	9		Calif.
1	0	0	0	0		1	1	9	8	4	0	0	0	0	1[31]	4	3	20	0	0	0	0	1	1	0	Colo.
33	20	6		1	6	0	7	16	24	1	0	24	0	1	1	25[32]	14	33	10	0	0	0	2	2	5	Conn.
3					1		1	2	1	2					2		1	5					1	1		Del.
3	0	4	0	0		0		17	62	2	0	4	0	0	0	5	6	14	0	0	0	0	0	0	0	Fla.
6	3	0	0	2	0	0	2	12	31	8	0	3	0	0	0	1	0	20	0	0	0	0	2[34]	1		Ga.
	2				0	0	0	3	14	3	2					4	1	4					1			Idaho
65	43	0		3	12	0	15	105	62	47	0	20	4	7	40	18	27	118	7	1	1	1	15	15	4	Ill.
12	6	2	0	0			1	28[35]	23[37]	20	4	41	1		11	3	1	20	0	0	0	0	4	2	1	Ind.
16	15	0			1	0	16	116	125	85	6	125	0	0	38	3	17	178	0	1	1	0	15	15		Iowa
25	2	0	0	2	1	0	0	79	29	32	14	38	<—9—>		30	0	21	118	0	0	0	0	18	10	2	Kan.
18	18	0	0	1	3	0	3	14	10	8	3		2	1	3	3	3	19	0	0	0	0	2	1	0	Ky.
	0	0	0	0	0	0	0	14	12	8	7	2	0	0	0	1	2	7	0	0	0	0	2	0	0	La.
					0	0	0	1	5																	Me.
18	1	2	0	0	17	0	2	17	2	10	0	2	1	0	8	12	8	25	0	1	1	0	0	0	0	Md.
13	2	0	0	0	18	0	0	6	2	5	0	31	0	0	5	0	0	17	0	0	0	0	0	0	0	Mass.
29	14	1		1			1[34]	9	16	13	5	3	9		2	11	10	31	3	2	2	0	7	1	1	Mich.
4	0	3	0	3	3	0	4	91	9	15	0	0	0	6	16	8	10	105	1	0	0	0	4	3	1	Minn.
4	2	0	0	0				6	35	3	1	2	0	0	1	7	3	4	0	0	0	0	0	0	0	Miss.
				2	5	0	4	57	29	23	4	0	0	1	5	7	5	60	1	0	0	1	1	1	1	Mo.
6	0	0	0	0	3	0		2	30	0	0	6	0	0	0	1	0	30	0	0	0	0	0	0	0	Mont.
					2	1		12	14	9			3					12								Neb.
																										Nev.
1	0	0	0	0	0	0	0	2	6	0	0	1				1	0	2		0	0	0	0			N. H.
1[21]	1[21]	10			161	1	14	59	112	36	7	28	4	1		85	29[34]	97	45				8		14	N. J.
13	2	0	0	0	11	0	17	13	12	2	0	0	0	0	0	2	2	13	0	0	0	0	2	0	0	N. M.
		15	4	4	13	1	22	82	59	35	8	17	3	1	25	94	32	87	40	1	2		22	22	7	N. Y.
27	26	0					7	47	48	13		11	4	0	16	7	6	80		5	5		5	5	0	N. C.
81		2								3		5			2			69	6							N. D.
96	26	2	1	6	46	1	12	64	0	23	13	30	4	1	20	26	18	75	13		3	3	12	12	3	Ohio
					1	3		120	42	64	4		1	3		20	2						4	4		Okla.
7	3	0	0	0	6	0	3	2	52	2	4	1	0	0	2	2	5	8	0	0	0	0	2	2	1	Ore.
183	11	1				0	14	127	101	103	24	33		2	105	118	19	175	21		0	0	10	10		Pa.
9[22]	3		1		2[23]	1	1	5[36]	14[38]	3[39]		15[40]			3	4[33]	1	11[35]	1	1	1		1	1[37]	5[38]	R. I.
					1			4	28			3				1										S. C.
4		3	3	1	2	1	5	54	4	24	0	6	1	1	8	1	8		0	0	0	0	7	7		S. D.
	0	0				0	0	19	58	6	0	1	0	0	0	3	0	13	0	0	0	0	0	0	0	Tenn.
250	250	5	0	200		0	5	242	85	90	4	165	17	4	25	97	20	355	2	1	1	0	11	5	10	Tex.
					0	0	0	0	17	1						2										Utah
																										Vt.
9	1	0	0	0	0	0	1	27	21	16	3	1	0	0	10	21	3	24	6	0	0	0	4	2	0	Va.
		1	0	1	5	0	1	2	29	1	2	0	0	0	0	9	2	5	0	0	0	0	1	1	3	Wash.
4	0	0	0	0	0	0	0	6	2	2	0	0	0	0	2	3	0	6	0	0	0	0	0	0	0	W. Va.
57		1	0	3	15	3	34	40	32	28	1	8	1	3	25	9	49		1	1	1	0	27	27	0	Wis.
																										Wyo.
																										D. C.
1,032	460	69	11	233	459	15	227	1,687	1,420	789	127	506	56	35	156	455	374	1,986	158	15	19	6	208	164	58	Total
													<—1341—>													
33	24	16	6	16	25	11	29	44	43	41	22	31	15	14	29	39	34	39	15	10	11	4	31	28	14	
													<—3—>													

ustrial and institutional plants only.
other plant uses congulants part of the time.
ustrial and institutional, 10; municipal, 8.
ustrial and institutional, 3; municipal, 2.
ustrial and institutional, 4; municipal, 19.
ustrial and institutional, 11; municipal, 3.
ustrial and institutional, 2; municipal, 1.
ustrial and institutional, 13; municipal, 2.
ooning.

[39]In most instances during summer months only.
[32]Equipment installed. Three plants chlorinate continuously.
[34]In addition, one district plant disposes of sludge at sea.
[35]Industrial and institutional, 7; municipal, 4.
[36]Partial collection only.
[37]Equipped for heating sludge-digestion tanks.
[38]In addition to the processes tabulated, there are 13 communities employing rapid sand filtration as a final purification step; Calif., 1; Ill., 2; Ind., 2; Ky., 1; Miss., 2; N. J., 1; Pa., 3; Wash., 1.
[39]In addition to the processes tabulated, there are 16 plants using Doten tanks; Calif., 3; Col., 1; Md., 1; N. J., 1; N. M., 3; Pa., 2; Va., 5. There also are 10 plants using Dortmund tanks; Mich., 2; Miss., 2; N. Y., 1; Tex., 5.
[40]Not distributed between sanitary and combined systems To be added to distributed totals shown.
[41]Not distributed between diffused air and mechanical aeration. To be added to distributed totals shown.

A Modern Water Supply for Turkey's New Capital City

The ancient town of Ankara, new capital of the republic, has been laid out as a modern city—Water is brought to the city from several underground sources through long pipe-line conduits and soon will also be obtained from an impounding basin

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TWO THOUSAND YEARS before Christ, according to the archeologists, the ancient Hittites settled at Ancyra (Angora or Ankara) in the heart of Asia Minor. Many other nations subsequently occupied the historical spot for a longer or shorter time, each systematically destroying what their predecessors had built. Romans, Byzantines, Persians, Arabs, Crusaders, Seldchuks, Osmans and Mongols in turn were attracted by the strategic position of its fortress on the northern royal route to Persia.

In 1923, on the instigation of Gazi Mustapha Kemal (now named Kemal Atutürk), Ankara, for political as well as strategic reasons, was chosen as the seat of the Republican Government of Turkey, and measures were taken for creating the elements necessary to make a capital city. A town plan was drawn up, linking the old native town of 40,000 to more modern quarters, where spacious governmental and other public buildings were erected, and grounds were reserved for an aerodrome, a racecourse, a stadium and recreation parks. On May 1, 1934, a census showed 84,423 inhabitants. A part of the new town, with the old city and citadel in the background, is shown in Fig. 2.

FIG. 1—THE CITADEL, at Ankara, Turkey, an ancient fortress on the road to Persia. The strategic importance of the site has led to its occupation by various nations since 2,000 B.C. In 1923 Ankara was chosen as the capital of the Turkish republic, and a new city was laid out on modern lines.

Fig. 2—PART OF THE NEW ANKARA, where modern governmental and other public buildings have been erected. In the background can be seen the old city and the citadel.

Water supply

The oldest water-supply system of Ankara probably reaches back to Roman times. Recent pipe-laying operations revealed parts of five different types of ancient conduits, three of which are shown in Fig. 3. The water was derived from sources in the Elma Dag (Apple Mountains) and was led by gravity to the town.

The old conduits having fallen into decay, the Vali Abidin Pacha in 1890 had two masonry canals built, utilizing water from the source Hanim Pinar, in the valley of Kayas, and from two springs in the Elma Dag (Fig. 4). In the city some cast-iron and wrought-iron pipes were laid and connected to public fountains.

Soon after Ankara was made the capital, credits were put at the disposal of the city administration by the Turkish government for modernizing its water supply. The scheme to be executed consisted mainly of the construction of an underground barrage in the valley of Kosunlar, a 10-km., 600-mm., cast-iron conduit, a distribution system and two reservoirs.

Financial difficulties in 1928 caused the operations to be temporarily discontinued. Water distribution was begun by the city authorities on a small scale, with the aid of three primitive pumping stations, provisionally installed at Kosunlar, Sahne and Hanim Pinar.

The government thereupon decided to take the matter in hand themselves and to follow the recommendations laid down in a report by the director general for hydraulic works, dated April 1, 1931. New credits were voted, and a governmental commission, to which the present writer was attached as a specialist, was entrusted with the carrying out of this program.

The report in its main lines recommended that: the underground barrage of Kosunlar be finished; the provisional pumping arrangement at Hanim Pinar be given a more permanent appearance; a complete distribution system be designed and executed; sources in the Elma Dag be captured and the water led by gravity mains to the town; and finally, investigations be made as to possible new sources of supply.

The underground barrage at Kosunlar, which is shown under construction in Fig. 5, consists of a concrete wall,

some 96.5 m. long, let into the solid rock, which shuts off the alluvial water-bearing strata in the valley. The groundwater enters through several layers of gravel of different size into a gallery, left in the wall; and after passing through a tunnel, 400 m. long, flows by gravity through the 600-mm. cast-iron main to the town. It may be remarked that a barrage of this type presupposes the possibility of underground water storage. In this case, however, such storage is rather small. The barrage possesses a watershed of some 40.8 sq.km., practically devoid of vegetation, with a mean annual precipitation of only 200 mm. and an evaporation figure of some 2,000 mm.

The distribution system had to be adapted to the mains already in existence. The differences in elevation

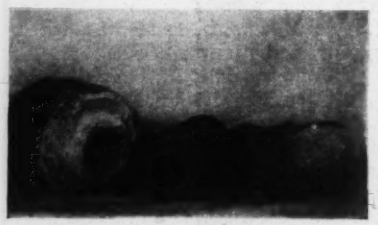

FIG. 3—THREE TYPES of old conduits unearthed by recent pipe-laying operations in Ankara, Turkey, whose first water supply was of Roman origin.

of the various parts of the town necessitated a division into ten different pressure zones, seven of which were provided each with a reservoir. The other zones are separated either by pressure-reducing valves or chambers. The total length of the system will be some 200 km., and that of the transport mains 58 km. The reservoirs, which are mainly built of concrete or reinforced concrete, are at Koca Tepe (1,000 cu.m.), Hisar (2,400 cu.m.), Bedestan (3,500 cu.m.), Cankaya (1,900 cu.m.), Cebeci (430 cu.m.) and Kale (180 cu.m.).

As a special feature, mention may be made of two hydrostat installations, utilizing an available pressure surplus for supplying a higher zone: one for the Kale zone, designed for lifting 12 liters per sec. to a height of 65 m.; the other, for Cebeci, consisted of three units, for lifting 14 liters per sec. to a reservoir located some 85 m. above the machines.

With a view to an efficient service control, recording flow meters were installed at different points, e.g. in several of the reservoirs; also automatic water-level transmitters, with private telephones to the central office, were installed.

In the Elma Dag several sources were captured, and the water led by gravity to Cankaya, the governmental district, the highest point of which was selected for building the President's palace. The mains cover some 35.5 km., including a tunnel of 145 m. and five siphons, one of which, descending into a valley, 200

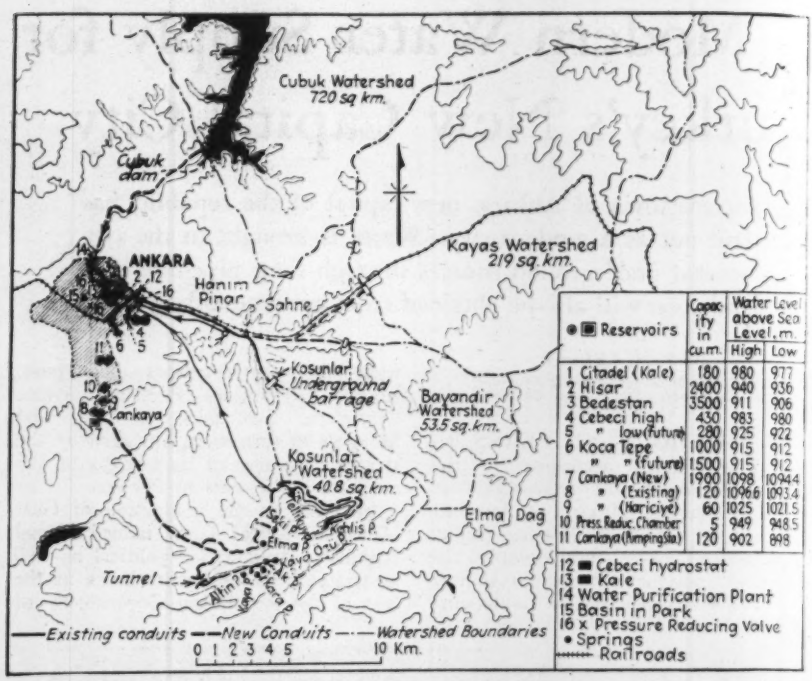

FIG. 4—THE CITY'S NEW WATER SUPPLY is drawn from underground sources to the east and soon will also be taken from the Cubuk impounding basin. At Kosunlar an underground dam and collecting gallery divert the underflow of the alluvial valley through a tunnel to a cast-iron conduit leading to the city. Water from wells in the Elma Dag (Apple Mountains) is led through cast-iron mains to Cankaya, the governmental district.

m. deep, is composed of two lines of high-pressure cast-iron pipe. The conduits are divided by pressure-reducing chambers into different sections, the service pressure generally not exceeding 35 m. After their completion the existing booster station for Cankaya, which lifted the water some 200 m., could be

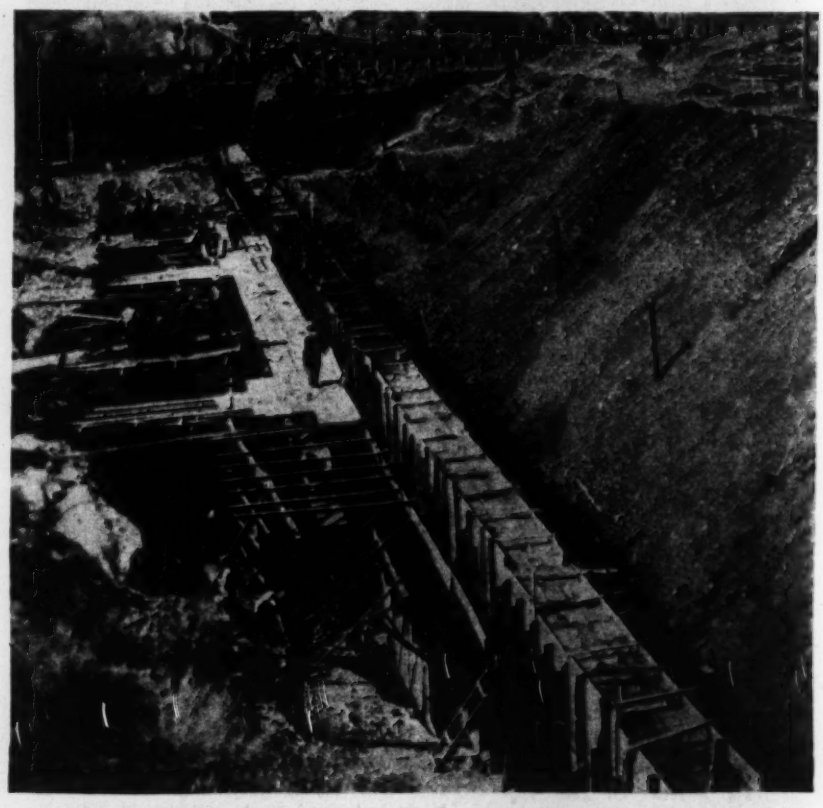

FIG. 5—UNDERGROUND BARRAGE at Kosunlar, under construction. It consists of a concrete wall, 96.5 m. long, keyed into solid rock and provided with a collection gallery.

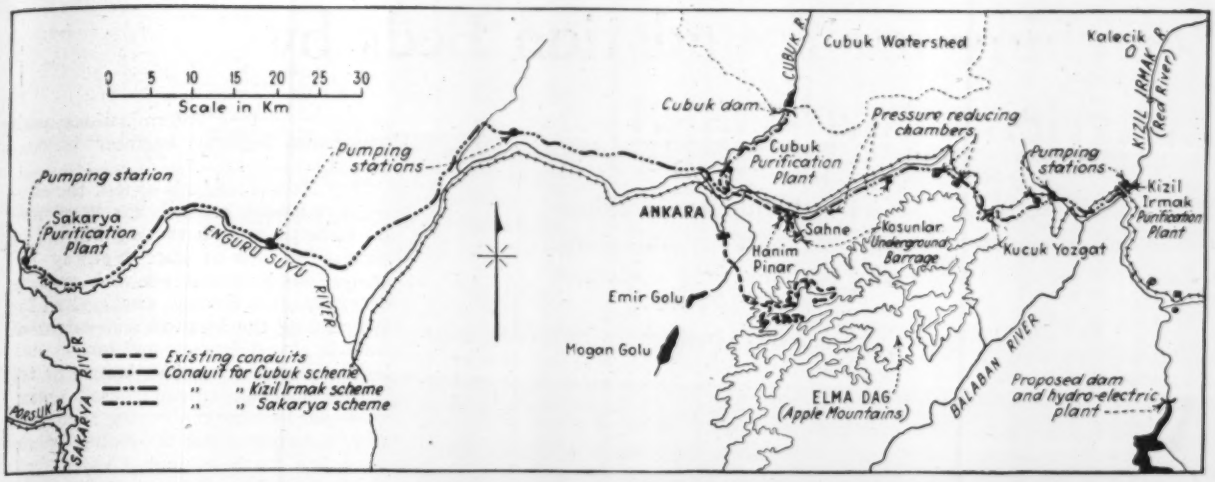

FIG. 6—THREE SCHEMES for additional water supply were given careful study: the Cubuk plan, the Kizil Irmak plan and the Sakarya plan. The Cubuk scheme was adopted for construction.

FIG. 7—CUBUK DAM while under construction. It is curved in plan, having a developed length of 252 m.

put out of service and its substantial running costs saved.

Borings, measurements of groundwater velocities by the Slichter method and other investigations, carried out in different valleys with a view to examining the possibilities of utilizing new water sources in the immediate neighborhood of the town, proved that the minimum water quantities available would not be sufficient for the future requirements of the capital, which might be put at some 278 liters per sec. Three other solutions, therefore, were examined—those indicated respectively as the Cubuk, Kizil Irmak and Sakaria schemes (Fig. 6).

The Cubuk plan proposed to utilize the water of an impounding basin of some 12,000,000 cu.m., to be formed after the completion of a concrete gravity dam then under construction 11 km. northeast of the city. This curved dam has a developed length of 252 m., the top being 25 m. above the bottom of the valley and some 58 m. above the deepest part of the foundation. The reservoir was originally intended for irrigation, but it was found that the watershed of 720 sq.km. would probably not always guarantee the quantities required for this purpose, while drinking water requirements could in all probability always be satisfied.

The Kizil Irmak (Red River) scheme was based on utilizing the water of the river of this name, the ancient Halys, 56.3 km. from Ankara by the shortest route. The water, after having undergone the necessary treatment at the intake, would have to be lifted over a pass in the Elma Dag mountain ridge, a difference in elevation of 550 m., necessitating at least three pumping stations. Electric current could eventually be produced by a dam to be built in the river 25 to 30 km. upstream of the intake. Construction of a tunnel over a certain length would have proved to be uneconomical. This scheme presented in certain respects a resemblance to the one chosen for Jerusalem, where, however, distances and differences in level are greater (72 km. and 914 m.) and four diesel pumping stations are required to overcome this difference.

The Sakaria project provided for the pumping of water from this river to the capital over a distance of 101 km. and against a static head equal to that necessary in the Kizil Irmak scheme.

For economic reasons and with a view to the desirability of immediate measures, the Cubuk plan was recommended over the other two, and credits were thereupon voted for the completion of the dam, the construction of a 600-mm. electrically welded steel gravity main, and the erection of the necessary purification plant near the town.

Water purification

The water from the existing sources was originally distributed without having undergone any previous treatment. Its hardness varies between 9 and 13 German degrees. It was felt desirable, however, to be armed against all eventualities, and measures were taken for installing chlorinating equipment.

For the purification of the water from the Cubuk basin a plant was designed comprising aeration, alum feed, sedimentation, rapid filtration and chlorination, eventually combined with ammoniation, as well as electrically driven pumping equipment, with room for a diesel stand-by. Alum feed can be effectuated before or after aeration; a hydraulic jump was provided with a view to the latter possibility.

All works were let after public adjudication, and were mainly executed by Turkish contractors; after being completed, they were successively transferred to the city authorities.

Water meters were systematically installed for all house connections, with a view to preventing waste and for augmenting the service's income, which formerly hardly counterbalanced the running expenses, capital being provided *à fonds perdu*.

Searching for Foundation Beds by Electricity and Sound

Experimentation by the Bureau of Public Roads demonstrates wide usefulness of both earth-resistivity and seismic subsurface surveys with easily portable field apparatus

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AMONG the problems of the road-builder is that of determining the character of the subsurface materials which he must excavate and those upon which he must build his bridges, underpasses and other structures. Too often such information is obtained at excessive cost or is neglected altogether. It was with the idea of bringing additional facilities into this field that the Bureau of Public Roads recently undertook to apply two geophysical prospecting methods to the relatively shallow determinations with which the highway engineer is concerned.

One of these methods of test, the electrical-resistivity method, has been used for some years with varying degrees of success by several state highway organizations in connection with grading operations, fills through swamps and for determining the location and extent of suitable gravel deposits and quarry material. The other method, known as the seismic method, although used extensively for locating oil-bearing structures and in certain types of mining operations, has not been applied extensively to shallow determinations. However, tests by the bureau over a period of several months on known formations around Washington indicate that, for determining the presence and location of consolidated rock, this method is more reliable and accurate and in other ways superior to the resistivity method (*Public Roads*, June, 1935).

FIG. 1—SEISMOGRAPH for field use developed by the Bureau of Public Roads, to determine subsurface soils in cuts and foundations.

FIG. 2—FIELD APPARATUS employed by the Bureau of Public Roads for subsurface surveys by measuring the electrical resistivity of earth.

Electrical-resistivity method

Although three different types of instruments are used for earth-resistivity measurements, they all embody the fundamental four-electrode principle first described by Wenner of the Bureau of Standards in 1915. The procedure is to introduce an electric current of known strength into the earth through suitably placed electrodes and by means of intermediate electrodes to measure the average resistivity of a volume of earth comparable in dimensions to the electrode spacing. By progressively increasing the electrode spacing and repeating the measurements a curve is established which shows the relation of resistivity to depth. Values of resistivity are plotted as ordinates and corresponding values of electrode spacing as abscissae. An upward trend of the curve indicates increasing resistivity with depth and suggests the presence of rock, gravel or some other high-resistance material, while a flat or descending curve is indicative of soil or clay. An abrupt change in curvature indicates a change in material at a depth approximately equal to the electrode spacing at which the change occurs.

Studies of this kind have been reported by the Bureau of Mines; by Schappler and Farnham, of the Missouri State Highway Commission; by Kurtenacher, of the Wisconsin Highway Commission; by Wilcox, of the Minnesota Department of Highways; and by numerous other investigators. Schappler and Farnham were successful in preclassifying excavation materials on highway projects but had difficulty in interpreting bridge sounding data due to the fact that coarse sand and gravel overlying the bedrock possessed a resis-

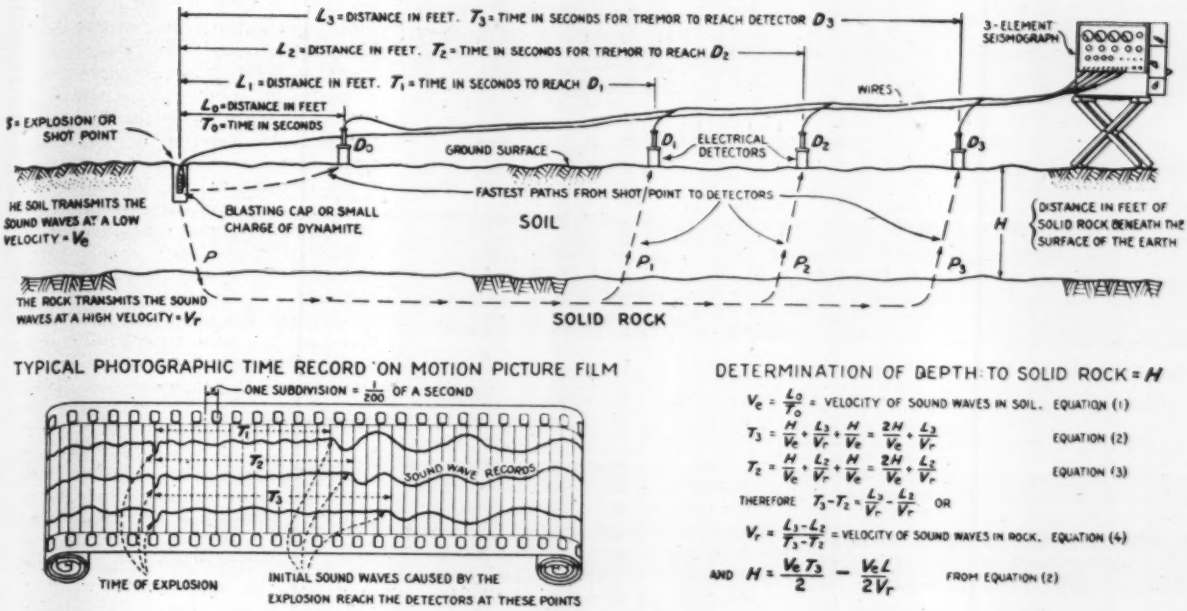

L_3 = DISTANCE IN FEET. T_3 = TIME IN SECONDS FOR TREMOR TO REACH DETECTOR D_3
L_2 = DISTANCE IN FEET. T_2 = TIME IN SECONDS FOR TREMOR TO REACH D_2
L_1 = DISTANCE IN FEET. T_1 = TIME IN SECONDS TO REACH D_1
L_0 = DISTANCE IN FEET
T_0 = TIME IN SECONDS
3-ELEMENT SEISMOGRAPH
WIRES
S = EXPLOSION OR SHOT POINT
GROUND SURFACE
ELECTRICAL DETECTORS
FASTEST PATHS FROM SHOT POINT TO DETECTORS
THE SOIL TRANSMITS THE SOUND WAVES AT A LOW VELOCITY = V_e
BLASTING CAP OR SMALL CHARGE OF DYNAMITE
SOIL
H
DISTANCE IN FEET OF SOLID ROCK BENEATH THE SURFACE OF THE EARTH
THE ROCK TRANSMITS THE SOUND WAVES AT A HIGH VELOCITY = V_r
SOLID ROCK
TYPICAL PHOTOGRAPHIC TIME RECORD ON MOTION PICTURE FILM
ONE SUBDIVISION = $\frac{1}{200}$ OF A SECOND
SOUND WAVE RECORDS
TIME OF EXPLOSION
INITIAL SOUND WAVES CAUSED BY THE EXPLOSION REACH THE DETECTORS AT THESE POINTS
DETERMINATION OF DEPTH TO SOLID ROCK = H
$V_e = \frac{L_0}{T_0}$ = VELOCITY OF SOUND WAVES IN SOIL. EQUATION (1)
$T_3 = \frac{H}{V_e} + \frac{L_3}{V_r} + \frac{H}{V_e} = \frac{2H}{V_e} + \frac{L_3}{V_r}$ EQUATION (2)
$T_2 = \frac{H}{V_e} + \frac{L_2}{V_r} + \frac{H}{V_e} = \frac{2H}{V_e} + \frac{L_2}{V_r}$ EQUATION (3)
THEREFORE $T_3 - T_2 = \frac{L_3}{V_r} - \frac{L_2}{V_r}$ OR
$V_r = \frac{L_3 - L_2}{T_3 - T_2}$ = VELOCITY OF SOUND WAVES IN ROCK. EQUATION (4)
AND $H = \frac{V_e T_3}{2} - \frac{V_e L}{2V_r}$ FROM EQUATION (2)

FIG. 3 — PRINCIPLES of seismographic method of subsurface-soil determination indicated diagrammatically, with equations for determining depth to rock.

tivity not markedly different from that of the solid rock. Kurtenacher reported success in the determination of the thickness of stripping on quarries, the location of buried gravel deposits and the determination of depths to solid bottom in marshes and swamps. Wilcox has confined his work largely to locating shallow deposits of sand and gravel for road surfacing.

The first practical application of the four-electrode method of measuring earth resistivity was made by McCollum of the Bureau of Standards and applied to the study of stray current electrolysis on underground pipes and cable systems. The McCollum earth-current meter embodies a dry battery, a milliammeter, a double commutator and a voltmeter having a resistance of 1,000,000 ohms per volt. The object of the commutator is to reverse the current periodically and thereby eliminate polarization, galvanic potentials and external stray currents.

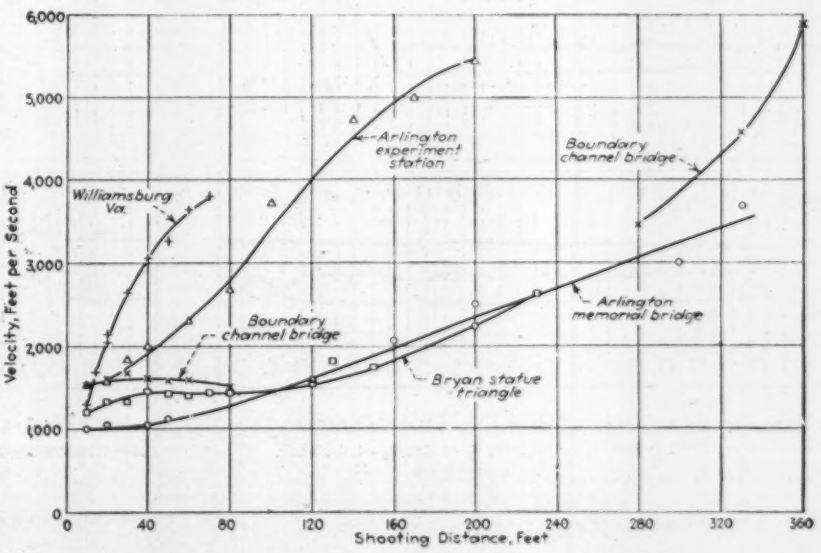
Gish, of the department of terrestrial magnetism and atmospheric electricity of the Carnegie Institute, modified the McCollum earth-current meter and measured the resistivity of large volumes of earth. His instrument embodied a larger and more accurate commutator than that employed by McCollum, and he substituted a potentiometer for the high-resistance voltmeter. He also introduced a condenser into the potential circuit to block the passage of galvanic and stray direct currents from the ground to the potentiometer, and reduced leakage between the current and potential circuits by the addition of a guard ring. This type of apparatus has been used quite extensively for geophysical explorations for several years past.

Another instrument, known commercially as the "Megger," was designed primarily to measure the resistance of driven and buried grounds for power stations and electric circuits, but it is also employed successfully under certain favorable conditions for subsurface explorations. The fact that this instrument must of necessity draw current from the potential electrodes is distinctly to its disadvantage. The error, however, is not serious in moderate-depth determinations if the contact resistance of the potential electrodes is kept reasonably low. This sometimes necessitates the use of water and rather long potential stakes. An improved megger, designed especially for geophysical work and embodying a potentiometer, is said to be now available.

Method employed by B.P.R.

Among the several methods of test used by the Bureau of Mines is that embodying a simple d.c. circuit with a reversing switch instead of a commutator. Non-polarizable potential electrodes are also substituted for the conventional iron stakes. Lee also introduced a center potential electrode by which it is possible to determine underground slopes by making independent measurements on either side of the center. This type of apparatus, a photograph of which is

FIG. 4—VELOCITY of sound waves through earth obtained by electrical seismograph.

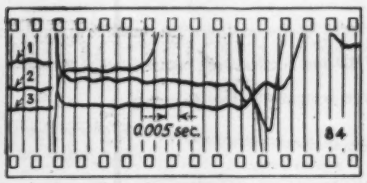


shown in Fig. 2, is the one adopted and used by the Bureau of Public Roads.

To eliminate the effects of galvanic potentials and stray currents, readings are taken with the test current flowing through the ground, first in one direction and then in the other. A fairly rapid technique has been developed which enables a crew of two engineers and two helpers to make from ten to twenty shallow tests per day. By shallow test is meant those involving such depths as are encountered in highway grading through rough country and requiring from six to twenty measurements at each location.

As to weight and portability, the megger and the earth-current meter are about on a par and considerably lighter than either the Gish-Rooney or the porous-cup apparatus. None of the instruments requires very accurate leveling. The Gish-Rooney apparatus is scientifically more accurate than any of the others and will perhaps yield satisfactory data over a greater variety of conditions than the others. For the relatively shallow depths encountered in highway construction, as well as for deeper determinations where stray current disturbances are absent, the porous-cup apparatus appears to be entirely satisfactory and is favored because of its low cost and its simplicity of construction and operation.

The most significant feature brought out by the bureau's studies over a period of more than a year is the wide range of resistivities in both soil and rock encountered within a comparatively limited area and the entire lack of uniformity and regularity in the upper layers of the earth's crust. Because of these conditions the interpretation of resistivity measurements is often indefinite or uncertain, and frequent correlations with known conditions should be made wherever possible.



Shooting distance $L_1 = 50$ ft, $L_2 = 100$ ft., $L_3 = 150$ ft

Time of wave travel from shot to detectors; $T_1 = 0.0355$ sec., $T_2 = 0.071$ sec., $T_3 = 0.074$ sec.

Ve = vel. of wave in earth $= \frac{L_1}{T_1} = \frac{50}{0.0355} = 1{,}400$ ft per sec.

Vr = vel. of wave in rock $= \frac{L_3 - L_2}{T_3 - T_2} = \frac{50}{0.003} = 16{,}700$ ft per sec.

H = depth to rock $= \frac{Ve\,T}{2} - \frac{L\,Ve}{2\,Vr} = \frac{1{,}400 \times 0.074}{2} - \frac{150}{2} \times \frac{1{,}400}{16{,}700} = 45.5$ ft.

FIG. 5—RECORD and calculation for rock depth at the Arlington Memorial Bridge.

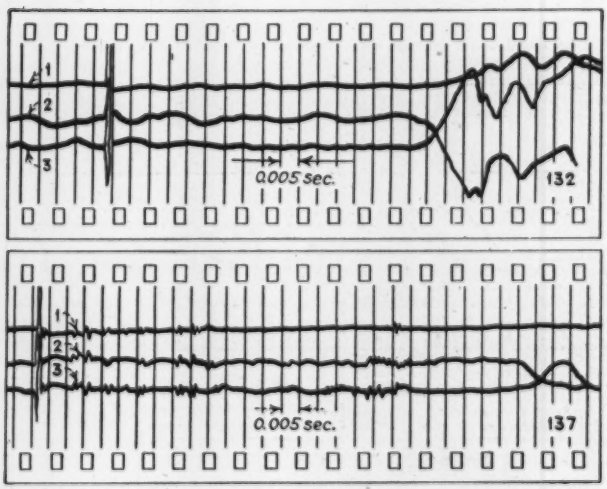
The results of tests in and around Washington indicate the possibility of utilizing such measurements to advantage in the classification of materials of excavation and in determining the depth and character of bridge-foundation materials.

The seismic method

The seismic method of exploration is based on an entirely different principle, and one which directly involves that property of the material with which the engineer is concerned—namely, rigidity. Non-rigid matter, such as sand, clay or gravel, transmits wave disturbances, commonly called sound waves, at velocities of 1,000 to 6,000 ft. per second, while rigid materials like rock or crystalline matter transmit such disturbances at 16,000 to 20,000 ft. per second. It is this property of subsurface materials that enables us to determine the presence and approximate location of consolidated rock. The seismograph is, therefore, more definite in its identification of solid rock than is the resistivity apparatus, but it cannot readily distinguish between clay and coarse sand or gravel, as can often be done by the resistivity method.

Although the seismic method of exploration has been successfully applied to oil prospecting and is distinctly the favorite of all geophysical methods, it has not heretofore been adapted to relatively shallow determinations. The reason for this is to be found in the rather formidable array of apparatus and equipment ordinarily required and the cost of such operations as commonly carried out. It was believed that a large part of the equipment required for deep prospecting could be eliminated or greatly simplified in an apparatus designed primarily for relatively shallow work, and that a simple and portable model of the more formidable apparatus could be constructed to meet these requirements. The most important difference between deep and shallow exploration that has made this accomplishment possible is the relatively short shooting distances involved in the latter. This eliminates the use of telephonic communication between the shot point and recorder as well as most of the cumbersome wire and reels. Only small charges of explosives are required, and these can be placed in a 1½-in soil-auger hole, thus

FIG. 6—RECORDS AND CALCULATION for rock depth at Boundary Channel Bridge.



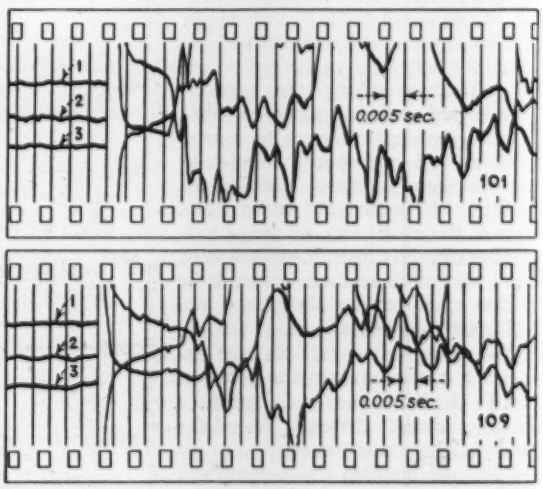
From film 132, $L = 110$ Ft., $T = 0.085$ sec., $Ve = \frac{L}{T} = 1{,}300$ ft. per sec.

From film 137, $L_2 = 330$ Ft., $L_3 = 360$ ft., $T_2 = 0.135$, $T_3 = 0.1385$ sec.

For $L = 360$ ft. depth to rock $= H = \frac{Ve\,T}{2} - \frac{L\,Ve}{2\,Vr}$

$= \frac{1300}{2} \times 0.1385 - \frac{360 \times 1{,}300}{2 \times 16{,}700} = 90 - 14.0 = 76.0$ ft.

FIG. 7—RECORDS AND CALCULATIONS of rock depths at Arlington Experiment Station.



From film 101, $L_1 = L_2 = L_3 = 30$ ft. $T = 0.0165$ sec., $Ve = \frac{L}{T} = 1{,}820$ ft. per sec.

From film 109, $L_1 = 120$ ft., $L_2 = 150$ ft., $L_3 = 180$ ft.

$T_1 = 0.0255$; $T_2 = 0.029$; $T_3 = 0.0325$; from $L = 150$ ft.

Depth to rock $= H = \frac{Ve\,T}{2} - \frac{L\,Ve}{2\,Vr} = \frac{1{,}820}{2} \times 0.029 - 75 \times \frac{1{,}820}{16{,}700} = 18.2$ ft.

eliminating the heavy drilling equipment required in deep work. The short shooting distances also permit of less sensitive instruments and the elimination of amplifying equipment with its attending complications.

With these modifications in mind, apparatus was assembled consisting of a three-element oscillograph with camera for photographic recording, three microphonic detectors or pick-ups and two 6½-in. spools of wire. Accessories consist of two camp stools, one 4-ft. soil auger, four dry cells or a small storage battery, one developing tank with developing and fixing solutions, and one changing bag. The entire equipment with a crew of three men can be carried in a small car and can be set up for operation in about 10 min.

The laborious calculations and involved formulas often employed in deeper determinations can also be dispensed with where shallow structures are concerned, and in their place a simple equation can be substituted, requiring only a mental process, or, at most, a slide-rule operation for its solution.

Seismic field apparatus

The essential units of the seismic apparatus are shown in the accompanying view (Fig. 1) of the field set-up and in Fig. 3. The detectors shown at the right of the picture are of the microphonic type, the resistance of which changes enormously with the slightest disturbance, thus making it a detector of exceptionally high sensitivity. While it is subject to some of the inherent defects of the carbon microphone, it is perhaps the only type of detector that can be used in the field successfully without amplifiers. This feature makes it particularly suited to shallow exploration work where simplicity and portability are of first importance.

The galvanometers are of the coil type having a d.c. sensitivity of about 4m. amp. per inch of deflection at 10 in. and an undamped frequency of 1,200 cycles per second. The elements carrying small reflecting mirrors are damped in oil. An optical system directs light from a 2.5-amp., 4-volt, straight filament lamp to the galvanometer mirror, whence it is reflected and brought to a point focus in the plane of the photographic film.

Time lines are obtained from peep-slits carried on the tines of an electrically driven tuning fork that vibrates at a normal frequency of 100 cycles per second. The camera used for moving the film is an adaptation of a Sept camera, an obsolete amateur motion-picture camera of French manufacture, which carries a standard 35-mm. film. A spring motor drives the film at 2 ft. per second. The film attains its maximum speed almost instantly upon starting the motor, which permits a record to be obtained with a film consumption of about 18 in. Standard, supersensitive motion-picture film is used, as it was found that less sensitive film did not give sufficiently dense traces. Records are developed in a dark room when convenient, or in a Leitz developing tank in the field. A changing bag is needed in transferring the exposed film from the camera to the developing tank.

This equipment, with the exception of the detectors, was built in the shop of the division of tests of the Bureau of Public Roads, after purchasing such items as galvanometers, tuning fork, lenses and electrical supplies.

Determining depth to rock

Two methods of seismic exploration in common use are known respectively as reflection shooting and refraction shooting. These terms have the same significance in geophysics as they do in optics, as the mathematical theory of sound-wave transmission through solids and liquids is based largely on the well-known laws of optics. As reflection shooting is not well adapted to shallow explorations, no further space will be given to a description of that technique.

The principles involved in refraction shooting are illustrated in Fig. 3. A blasting cap or small charge of dynamite is exploded at or under the surface of the ground at some point S, which becomes the center of a wave disturbance moving outward on a spherical or near-spherical front in all directions. The breaking of a small wire that is wound around the blasting cap gives an initial kick or impulse to the three galvanometers, and the time of explosion is thereby indicated on all three traces.

The path of the first disturbance to reach any detector will depend upon the ratio of the shooting distance, L, to the depth of rock, H, and also upon the relative velocities of wave propagation in the two media. If the shooting distance is relatively short, such as L_0, the path of the first disturbance to reach D_0 will be directly through the soil as indicated. The velocity of the wave through the earth can then be calculated from Eq. 1, Fig. 3. As the shooting distance is increased, a point such as D_2 will be reached where the wave first to arrive will no longer be that going directly through the top soil but that taking the path of the refracted wave SPP_2D_2. Subsequent disturbances will reach detector D_2 by various paths, but as only the first arrival can definitely be identified on the film record it is necessary to base interpretations solely on so-called first events. Likewise, the first wave to reach D_3 will be by the path SPP_3D_3. By measuring the time difference T_3-T_2 and the distance L_3-L_2 we are able to calculate the velocity of wave propagation through the rock, from Eq. 4, and finally the depth to rock, H, as indicated in Fig. 3.

When the distance L_2 is of such value that the direct wave through the earth reaches detector D at the same time as the refracted wave, it is said to be the critical distance. For best results, when determining depths to rock, L should not be greatly in excess of the critical distance. As a fairly close approximation we may say that for values of V_e and V_r usually encountered, $H = 0.45\ L$, or $L = 2.2\ H$, where L is the critical shooting distance.

Various modifications of the technique just described are sometimes necessary to determine slopes, domes and other irregularities in underground structures. The depth to rock H, as given in the equation, is really the average of the depth at the shot and that at the detector. By shooting a line of detectors from opposite directions, an estimate of the slope can be obtained. Circle shooting is another means of studying subsurface irregularities. This consists in placing two or more detectors on the arc of a circle, the radius of which is greater than the critical distance, and the center of which is the shot point. The order in which the waves reach the detectors will indicate the relative rock depths under them, the shorter time indicating the shallower rock.

Experimental tests

The accuracy with which H can be determined will depend largely upon the value of V_e selected. In most soils the

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value of V_e increases with depth, and the value to be substituted in the equation must therefore be intermediate between the velocity in the topsoil and that in the deeper strata. Fig. 4 shows several velocity-distance curves from which values V_e were selected in determining rock depths at these locations.

Fig. 5 shows a single record from which the rock depth at the Memorial Bridge can be calculated. The three detectors were spaced respectively 50, 100 and 150 ft. from the shot. In this case the critical distance appears to be almost exactly 100 ft. This follows from the fact that the middle trace shows the same velocity as does the first trace, thus indicating that the wave could have traveled directly through the earth, but when compared with the third trace the time interval is such as to give a velocity of 16,700 ft. per second, which is very close to rock velocity. It is evident, therefore, that the time of travel to the second detector is the same by either the direct path or the path of the refracted wave through the rock, a condition which determines the critical distance.

Fig. 6 shows records from which the depth to rock at the Boundary Channel bridge was calculated as 76 ft., a figure which checks closely with the bridge engineer's data.

Fig. 7 shows some of the records from which the depth to rock on the Arlington experimental farm were calculated. The average calculated depth of 18.2 ft. as determined from several measurements is a fairly satisfactory figure in comparison with the actual depth of 19.8 ft. as determined with a soil auger.

A few tests have been made at quarry sites and at other locations where solid rock is found within a few feet of the ground surface, and all indicate that the depth of such overburdens can be determined quickly, definitely and accurately by the seismic method. For such work a single No. 8 blasting cap gives ample energy, thus reducing the cost of explosives to a negligible amount.

While the bureau's work with the seismograph has been largely experimental and limited to one locality, the results to date are so promising as to leave little doubt as to the ultimate value of this tool in the study of subsurface formations.

Muskingum Flood Control Forges Ahead

Country's largest reservoir flood-control project, being built in southeastern Ohio, has been planned and put under contract in twelve months

IN THE HILLS of southeastern Ohio there is now under way the largest flood-control project by reservoir retention ever built in this country. It is being built by the Corps of Engineers, U. S. Army, with funds provided by PWA, the state and local interests. A year ago the first of May, money was made available by PWA. The following twelve months were filled with feverish activity on the part of the engineers in studying the hydrography, geology and topography of the 8,000 square miles comprising the Muskingum River drainage basin, selecting reservoir sites and designing the fourteen dams finally determined as providing adequate flood protection within reasonable cost limits. During this period the Muskingum Valley Conservancy District, a newly-created public agency, was also busy preparing assessment rolls and in securing rights-of-way. By May 1 of this year contracts for ten dams had been let, and work was well along on five of them. By July 3 all the dams were under contract.

The Muskingum River Basin comprises one-fifth of the entire 40-000-sq.mi. area of Ohio, and the flood-protection plan controls 4,267 square miles of drainage by reservoirs, or more than half the basin area. Planning the control system was a difficult task, for the basin is dotted with small cities and towns, many of them industrial centers, and is threaded with railroads, highway routes, natural-gas pipe lines, oil lines, power-transmission lines and other utilities. The entire cost, including land damages, construction costs, highway, railroad and utility damages, will be about $35,000,000.

Floods long a menace

From the time this part of the state was first settled, the towns and communities have been subject to frequent damage from high water, culminating in the disastrous flood of March, 1913, when the entire Ohio River Valley had the highest flood on record. Though the 1913 flood was not as destructive or spectacular in the Muskingum Valley as in the Scioto and Miami valleys to the west, every community in the area suffered extensively, and the damage ran into millions.

For years local interests have attempted to solve the flood problem, for almost every year some part of the valley has been flooded, but the cost involved was always found to be prohibitive. With the advent of government financing of public works in the summer of 1933, the Muskingum Valley Conservancy District was created under authority of the Ohio conservancy law, June 3, 1933, and given wide powers. The following August a PWA application for funds was filed, and in December, 1933, the sum of $22,090,000 was allotted by PWA to the War Department for the construction of the long-desired flood-control system. A contract between the district and the government was executed March 29, 1934, and money was made available April 30.

The contract provided that the district should furnish all reservoir and dam sites, take care of all highways involved, and maintain and operate the system. The state came to the aid of the district by appropriating $2,000,000 toward the expenses, and further undertook the relocation of all state highways at a cost of $4,000,000. This left about $6,000,000 to be paid for by assessment of benefited lands within the drainage basin. Engineering and construction costs and relocation of railroads and public utilities will be met by the $22,000,000 federal fund.

Official plan developed

Two main streams drain the upper part of the Muskingum Basin. The Walhonding River from the northwest joins the Tuscarawas River from the northeast at Coshocton, to form the Muskingum, which flows into the Ohio at Marietta. Zanesville, next to Canton, the largest city lying wholly within the basin, (Akron is at its northern edge), lies on the Muskingum at the mouth of the Licking River. One other stream, Wills Creek, coming into the Muskingum from the east between Zanesville and Coshocton, is of importance in the flood-control plan.

In a limited time and with practically no funds for investigation, the district evolved a plan embracing fourteen reservoirs, all on streams above Zanesville. This scheme, now known as the preliminary plan, provided for flood control of 60.7 per cent of the 6,840 square miles of drainage area above Zanesville (including the Licking River), 82 per cent of the Walhonding Basin, and 32.4 per cent of the Tuscarawas area. The concentration of reservoirs in the Walhonding area was the result of a belief that the northwest section was subject to heaviest rainfall, a theory disproved by subsequent studies.

Having the data developed for the preliminary plan and earlier reports on the Muskingum, the engineers made a new and complete study of the entire situation, and soon submitted a new scheme, the official plan, on Aug. 1, 1934. This plan was approved by all concerned, including the courts, and is now being carried out. It originally pro-

vided for fifteen dams and reservoirs, of which one, at Massillon, has been abandoned in favor of another site at Bolivar, because of excessive railroad relocation costs; another, a small dam at Freeport, has been discarded for the present. This leaves fourteen dams in the official plan, with 62.4 per cent of the basin above Zanesville controlled, and 66.7 per cent of the Walhonding and 74.2 per cent of the Tuscarawas areas placed under control. Channel improvements and protection works at Massillon, to cost $1,850,000 will give that city practically the same security as contemplated by the dam originally scheduled for a location just above the town. (For early developments of the project and certain features of the official plan, see *ENR*, June 21, 1934, p. 799, and Nov. 1, 1934, p. 563.)

Thorough studies made

On Jan. 15, 1934, the engineers established temporary headquarters at Zanesville. The magnitude of the job was soon apparent, and, to handle the work more effecitvely, the Muskingum area was made a separate engineering district, with Major J. D. Arthur, Jr., as district engineer. T. T. Knappen, formerly area engineer at Cairo, Ill., was made chief of the engineering division, charged with the necessary studies and plans.

As rapidly as possible the engineering organization was set up in the form shown in the chart, Fig. 2. Four main sections were formed: office, survey, planning and engineering, and later a hydraulic model-study section was added, working with the engineering section. These main sections were broken down into various subsections, especially the planning section, where work was heaviest. A consulting board of army and civilian engineers aided in the planning. Before long, the staff comprised over 400, all working day and night, Sundays and all, on a rushing, but well-controlled program of investigation, study and planning.

Seven main phases of the flood-control problem were studied: hydrology, floods, reservoirs, dams, spillways and outlet works and relocation, channels, flowage, and local protection. All through the investigation and planning period two factors were kept in mind—adequate protection and reasonable cost, the economics of the case being kept in mind at all times.

The study of hydrology included gathering of every available rainfall record through the entire area, and making analyses of past and probable future rainfalls. The flood of 1913 was reconstructed from river-gage records, high-water marks, newspaper accounts, and stories of eyewitnesses.

The study of reservoirs, capacities and sizes included 151 dam and reservoir sites, investigated briefly or in detail as required, but all thoroughly enough to reveal their suitability or undesirability. One study contemplated numerous small dams instead of fewer large reservoirs. Some 50 sites were finally chosen for this plan, but because of the poor flood control provided it was soon abandoned.

As soon as a reservoir site was tentatively selected, studies were immediately begun to determine the type of dam, spillway and outlet works best suited to the site conditions as revealed by core borings, test pits, geophysical explorations and topographical surveys. For this important work a permanent staff of geologists was added to the engineering organization.

One of the best equipped soils laboratories in the country was established at Zanesville for research in earth-dam design and for testing foundations and available borrowpit materials at every dam site. Thousands of feet of core borings were classified and analyzed by the laboratory; thousands of samples from borrowpits and dam sites were tested for various characteristics.

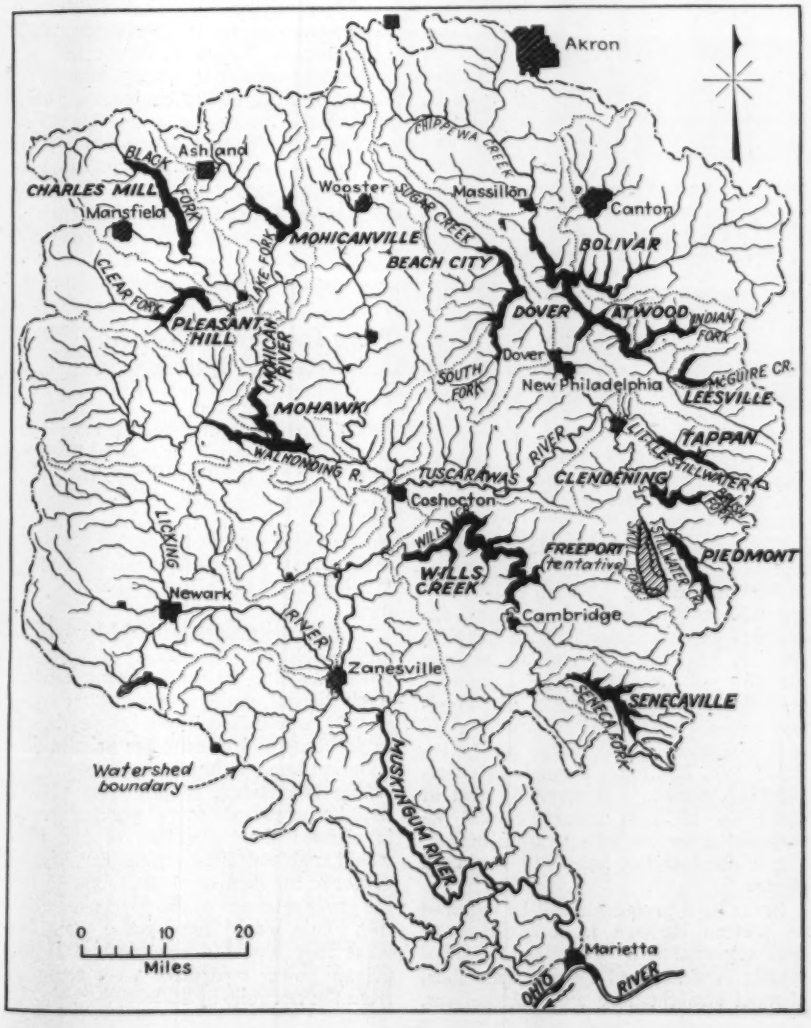
In only one instance, the Dover Dam, was a concrete structure found to be best. All others are rolled-earth embankments of varying side slopes, widths of core and proportions of rockfill, except that on the Bolivar Dam, hydraulic filling is optional with the contractor.

From data furnished by the soils laboratory the engineers estimated the necessary moisture content of the soil and the amount of rolling required to obtain best compaction. In construction of the embankments any lack of required moisture is overcome by sprinkling the fill between rollings. The compaction desired is converted to theoretical weight of compacted material, frequently checked by taking a boring and weighing the sample on the spot.

Economic studies of railroad, highway and utility relocations were carried along with the reservoir investigations, and these led to rejection of several desirable dam sites. Principal floodway channels were investigated, to determine their carrying capacity, to obtain the relation at critical points between normal flow and flood stage. The Conservancy District made most of the studies of flowage damages.

To check the hydraulic design of out-

FIG. 1—OFFICIAL PLAN of reservoirs for flood control of Muskingum Valley, Ohio.



let and spillway works, model studies of eleven dams were made in the hydraulic laboratory at Case School of Applied Science in Cleveland by engineers from the Zanesville office under the direction of Prof. Geo. E. Barnes. As a result, numerous changes were made in the original designs, mostly to prevent scour at the discharge end of the works.

Probably the most interesting study was that made on the Pleasant Hill Dam, which will have a morning-glory type of spillway 100 ft. high, with a crest of 80-ft. diameter and a 20-ft. circular throat, discharging into a tunnel. The controlled outlet works consist of a gate tower, also discharging into the tunnel. In the model the tunnel section was made of pyralin, to permit observation of hydraulic action of the two streams coming together.

Plan of operation

Under the official plan the reservoirs are designed to fill to the spillway level, but not to overflow, during the assumed maximum storm—a five-day rainfall, 36 per cent larger than that of the five-day storm of March, 1913, and about equal to the heaviest precipitation at any point in the area during the 1913 storm.

TABLE I—PRINCIPAL QUANTITIES IN FOURTEEN MUSKINGUM DAMS

Earth excavation, cu. yd.	10,000,000
Rock excavation, cu. yd.	1,000,000
Earth embankment, cu. yd.	9,000,000
Rockfill, cu. yd.	700,000
Concrete, cu. yd.	400,000
Reinforcing steel, lb.	4,000,000
Structural steel, lb.	1,200,000
Cast iron, lb.	1,500,000
Cast steel, lb.	150,000
Steel sheetpiling, lb.	600,000
Tunnels, cu. yd.	40,000
Grouting foundations, lin.-ft.	20,000
Riprap, cu. yd.	200,000
Sod for embankments, sq. yd.	80,000
Cement, bbl.	600,000
Gravel, cu. yd.	350,000
Sand, cu. yd.	175,000
Railroad relocations, miles	80
Railroad grading, cu. yd.	5,000,000
8,000 men	15,000,000 man-hours

TABLE II—PROGRESS IN GETTING WORK STARTED

Dam	Plans Completed	Open Bids	Award Contract	Constr. Period, Days
1. Tappan	Sept. 30	Nov. 13	Nov. 24	365
2. Charles Mill	Oct. 4	Nov. 15	Nov. 24	365
3. Wills Creek	Oct. 6	Nov. 21	Jan. 22	700
4. Clendening	Dec. 6	Jan. 31	Feb. 5	320
5. Beach City	Dec. 24	Feb. 21	Feb. 26	600
6. Mohawk	Jan. 16	Mar. 19	Mar. 27	800
7. Senecaville	Jan. 26	Apr. 2	Apr. 12	600
8. Piedmont	Feb. 7	Apr. 10	Apr. 19	570
9. Mohicanville	Feb. 18	Apr. 30	May 10	570
10. Dover	Mar. 4	May 3	May 14	700
11. Leesville	Mar. 21	May 24	June 3	550
12. Pleasant Hill	Apr. 15	June 24	June 28	700
13. Atwood	May 24	June 26	July 3	520
14. Bolivar	May 28	June 27	July 2	800

TABLE III—EFFECT OF OFFICIAL PLAN ON 1913 FLOOD

Place	1913 Flood Stage, Ft.	O.P. Max. Flood Stage, Ft.	Reduction, Ft.
Loudonville	24.1	14.7	9.4
Warsaw	21.0	7.3	13.7
Dover	16.8	4.8	12.0
Coshocton	28.8	18.4	10.4
Zanesville	51.8	34.4	17.4
Marietta, discharge in sec.-ft.	282,000	156,000	126,000

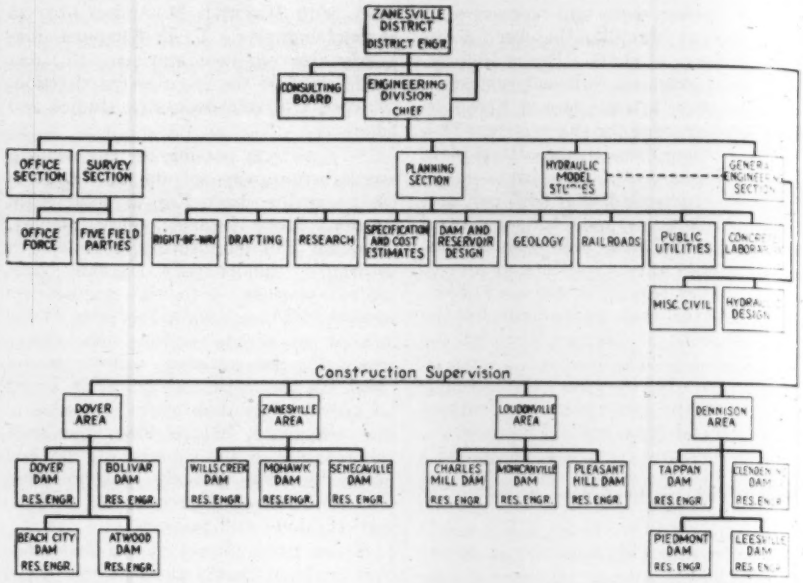


FIG. 2—ORGANIZATION CHART of engineering staff of Zanesville district office.

The theoretical five-day storm comprises 10 in. of rainfall in five days, distributed daily as 1¼, 2, 4, 1¾ and 1 in. (the same daily ratio as occurred in 1913 at Coshocton). All spillways are designed to pass a storm with a volume about 25 per cent in excess of any recorded storm between the Allegheny Mountains and the Mississippi River (10- to 17-in. rainfall in three days, depending upon size of drainage area), with all outlet gates closed on a full reservoir.

The reservoirs are primarily for flood control, but most of them are designed also for conservation storage for dry periods. Conservation storage will be restored as soon as possible after a dry season; likewise, excess flood storage will be released as soon as practicable to keep the reservoirs at conservation pool level. Reservoir lands covered by the conservation pools are being cleared, but no work is being done on the remainder of the reservoir sites, except removal of buildings.

Operation plans contemplate full-time operators at each dam for manipulation of the outlet works. A central dispatching office will be set up from which operations will be directed. With complete data on hand as to immediate storage capacity of each reservoir, rainfall records and weather reports, and floodway channel capacity of the Muskingum, it is expected that floodflows can be reduced to a minimum through this despatching system. A standard plan of operation of each reservoir will be formulated for use by operators in case the communication lines fail during a storm.

Some local protection will be required to prevent damage from overflow of floodway channels. These consist principally of dikes and levees, with some channel straightening and enlargement.

Design and construction are under the direction of the Corps of Engineers, Major-General E. M. Markham, chief of engineers. Major J. D. Arthur, Jr., is district engineer in charge, with T. T. Knappen chief of the engineering division of the Zanesville office. Heads of various departments are given in the chart, Fig. 2. For the Muskingum Valley Conservancy District C. C. Chambers is chief engineer.

Plans for Power Districts Advanced in Washington

Plans calling for the formation of power districts in an effort to save huge tax losses that would be caused by state ownership of public utilities are being advanced in the state of Washington. The Home Rule Power League is sponsoring a plan which calls for the purchase of all private power properties in western Washington and in the Wenatchee district.

The league program would be accomplished by the formation of separate power districts in nearly every county. Each district, under a referendum voted in 1933, would float its own utility bonds to purchase and operate the private distribution lines within its borders.

The referendum requires the voters' sanction of private power purchases. It is claimed that operation of the plan would enable all the cooperating cities to conserve for themselves the right to tax the gross revenues of the purchased utilities. This would recompense them for what they would otherwise lose if the private power companies were removed from the tax rolls by state ownership.

Letters to the Editor

Sealing Clay With Salt

Sir—The interesting article on salt-stabilized road practice (*ENR*, July 4, 1935) contains a clear statement of a phenomenon of soil physics which has possibilities of practical engineering applications other than in earth-road maintenance.

In 1929 the writer made a series of tests with various alkali salts, to determine the practicability of sealing the leaky bottom of an earth reservoir. The soil was a dark-gray adobe, classified by the U. S. Bureau of Soils as "Antioch clay loam." It was about 3 ft. in depth, and during the summer dry season developed extensive cracks due to shrinkage.

As is well known to soil physicists, acids and neutral salts when applied to clayey soils produce flocculation with resulting increase in permeability. Strongly alkaline salts such as soda ash (NaO_2) on the other hand produce deflocculation, breaking up and diffusing the colloidal aggregates and rendering the soil impermeable. The fact not so well known, which is now being applied by Dr. Ries, is that the application of certain neutral salts such as common salt (NaCl), if followed by washing with fresh water would produce the same effect as the application of strongly alkaline salts. The writer's tests upon Antioch clay loam convincingly confirmed this fact and indicated that for a 3-ft. depth of soil less than 20 tons of salt per acre would render it completely impermeable. Plans were made to spread the salt before filling the reservoir and just prior to the winter rains, allowing the latter to dissolve and distribute it through the thoroughly cracked soil.

Largely because of uncertainty as to permanency, the plans for using the salt method were abandoned in favor of colloidal bentonite. It is with renewed interest, however, that the writer read in your article of the practical application of the salt method, and his belief is confirmed that in certain cases it could be used to control excessive leakage from earth reservoirs inexpensively.

CHARLES H. LEE,
Consulting Engineer.

San Francisco, Calif., July 22, 1935.

Hard-Facing Materials Confused

Sir—In the article "Rotating Foundation Caissons Drill Their Way to Rock" (*ENR*, July 11, 1935), there is a slight error to which we would like to call your attention. The second paragraph on p. 40 mentions that the life of the centrifugal pump bearings was increased from 4 to 40 caissons by coating the bearings with tungsten carbide. Actually these bearings were coated with Haynes Stellite, a non-ferrous hard-facing alloy of cobalt, chromium and tungsten. This error was evidently occasioned by the fact that tungsten carbide, with the proprietary name of Haystellite, is mentioned previously in the article as being used for hard-facing the cutting teeth of the caissons.

We are bringing this to your attention simply because welding rod containing crushed particles of tungsten carbide produces a somewhat rough irregular surface suitable only for wearing parts that do not require a smooth finish. This material would not be at all satisfactory on bearings that must be ground to an accurate fit.

GEORGE SYKES,
Haynes Stellite Co.

New York, N. Y., July 16, 1935.

Runoff of 34 Per Cent Solids After Denudation of Watershed

A FIRE - DENUDED watershed, drenched by heavy rainfall, last fall discharged such a large quantity of solids into Devil's Gate Reservoir at Pasadena that a survey was made to establish actual figures. The storm was found to have brought into the reservoir solids that occupied storage space equal to 34 per cent of the total volume of runoff. Data for the following outline of the case were supplied by S. B. Morris, chief engineer and general manager, Pasadena water department.

Devil's Gate Dam, near the foothills at the westerly edge of Pasadena, was constructed by the Los Angeles County Flood Control District in 1920. It is located in Arroyo Seco, 1½ miles below where the channel debouches from the steep slopes of a mountain canyon. The total drainage area above the dam is 30 square miles, of which 21.7 square miles is largely steep mountainous canyons. Prior to last year no serious forest fires had occurred here for 35 or 40 years, and a large part of the area was covered thickly with brush.

On July 26, 1934, with a temperature of 112 deg. and humidity of only 12 per cent, a brush fire broke out in Arroyo Seco Canyon and, despite strenuous efforts to check it, burned for two days and nights, denuding 3,550 acres.

Some three months later heavy rain fell for two days on this same area. On the first day of the storm the precipitation in near-by Pasadena was 3.26 in., and on the second day 0.77 in. The first rainfall caused many slides and mud flows in the burned-over area, including heavy erosion of new highway fills in the canyon. Surveys had been made in the reservoir at intervals prior to the storm, and these were supplemented by additional surveys made after the subsidence of stormwaters to determine just what changes had occurred.

The total accretions due to silting up of the reservoir in the period from October, 1920, to September, 1934, amounted to 704 acre-ft., or 1.43 per cent of the total inflow of 49,174 acre-ft., recorded as entering the reservoir in the fourteen-year period.

Total runoff from the storm of October, 1934, was 480 acre-ft., and this inflow brought into the reservoir 145 acre-ft. of solids, or 34 per cent of the total volume of runoff. The solids are estimated to have 40 to 45 per cent of voids, so that if their quantity were to be calculated on a net volume basis the figure would be about 18 per cent of the runoff. The large amount of slide material deposited in and near the channels above the reservoir suggests large future inflows of silt irrespective of success of the plans for preventing further erosion.

Output of Treated Timber Increased During 1934

A report prepared by the U. S. Forest Service in cooperation with the American Wood-Preservers' Association indicates that during 1934 the output of treated timber increased 33.7 per cent, with individual items showing an increase of 25 to 69 per cent. The total production of treated timber in 1934 was 2,021,258,568 b.ft.

The greatest increase was evidenced in ties, poles, lumber and piles. Of the 28,459,587 ties treated, electric railroads used 208,220, representing an increase of 85 per cent over 1933. Treated poles of all types showed a combined increase of 51 per cent, and full-length treated poles, mainly pine and Douglas fir, showed an increase of 69 per cent. A comparison shows a steady increase in pressure treatment of poles. During 1934, 73.2 per cent were pressure-treated, and about 92.7 per cent of all timber treated was given pressure treatment.

Miscellaneous treated lumber, for mine timbers, car material and pipe staves increased from 38,631,913 b.ft. in 1933 to 64,703,759 b.ft. in 1934. The output of treated mine timbers alone increased from 298,026 to 3,066,145 b.ft. Miscellaneous material treated with other than creosote or zinc chloride decreased about 17 per cent, while 98.3 per cent was treated with zinc chloride or creosote.

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August 15, 1935

Two Years at Panama

FOR MOST MEN of today the passage of three eventful decades since the building of the Panama Canal began has caused that great adventure to recede into the shadowy background of history and to lose its sharply marked features, to the degree of appearing almost as a routine task. The memories recorded by John F. Stevens, its chief engineer and first construction dictator, whose first article on the historic theme appears in the present issue, bring before the eye with graphic clearness the tremendous difficulties faced by those who undertook this task. Men of heroic stature and high ability, laboring with singular devotion, were indispensable to its accomplishment under the conditions that prevailed. Of the two major stages of the construction activities—one, the planning and preparation and getting the work under way, the other, carrying on under high pressure the construction campaign thus prepared and initiated—the present articles tell of the first and fundamental one. It was the period of civilian management and of critical decisions. Mr. Stevens' vivid personal account provides the basis on which its vital importance to the ultimate achievement may be judged.

After the Drought

NEWS OF DESTRUCTIVE FLOODS in Wisconsin and Ohio, following on those in New York, in Kansas and in the western Great Plains region, even though they come at so unseasonable a time as the dog days, should be no great surprise in view of the long period of subnormal rainfall. The tendency toward equalization of natural events is unmistakable; it is inherent in their essential constancy and continuous variation about an average. If the motive causes of the variation were fully understood, we might find that the compensating tendencies bear some relation to the extent of prior departure from the mean. Unusually severe drought, for example, might prove to be a predisposing cause of abnormal rains. The current season's flood rains, including both sustained storms and cloudburst downpours, give support to such a belief. A year ago, following the parched summer months of 1934 in the Midwest, we urged that flood dangers be given thought as the possible sequel of extreme dry weather; but the drought cycle had not reached its bottom, as later appeared. This summer's abnormally heavy flood rains add force to that urging by demonstrating once more the reality of the ever-present flood hazard. It is a threat that no valley community and no state can afford to ignore.

Stream-Basin Control

WHAT IS BEING DONE in the Muskingum Valley in Ohio to control floodflows throughout the basin of the stream presents an excellent picture of a type of work that is needed in all parts of the country. The fact that most flood problems are not local but regional, that they involve not a city alone but usually many counties, has been known almost as long as floods began to be studied. But the classic control operations carried out in the valley of the Great Miami River in Ohio after 1915, as a sequel to the unprecedented flood havoc of 1913, stand as almost the sole practical application of this recognition, at least in the western world. The Muskingum works, covering an even larger region, will give Ohio a second example of purposeful solution of the flood problems of an important stream basin. But Ohio is in no way different from other states, and the Muskingum and Miami are no different from other streams, in respect to flood risk. The hazards that exist along these two rivers are duplicated in hundreds of valleys throughout the country, and the same reason exists in virtually every state for studying flood probabilities, working out efficient and economical protective plans, and organizing to carry them out. The next twenty years should see regional flood control provided in many more valleys—or we are likely to hear of preventable flood disaster repeated time and again.

Engineering Ingenuity

THE DECISIVE INFLUENCE of approach roads on the proportions of a bridge structure is well instanced by the Triborough project, whose tower construction is dealt with in this issue and whose development was discussed briefly last week. The bridge was originally planned with two decks, to carry sixteen vehicle lanes, but later consideration of the capacity of approach roads that were economically feasible showed that eight lanes would be adequate. The subsequent redesign necessitated by this decision called for engineering ingenuity of high order, since the anchorages and piers were completed and fabrication of the towers had begun. In fairness to the original designers it should be said that they were operating under different conditions than came about later, when all interested authorities were unified. Nevertheless the redesign placed a major problem before the bridge engineer's skill. By eliminating the two middle cables of the original design and using the outer anchorages only, in spite of their wide spacing, a maximum of the completed work was salvaged. The resulting structure, with its wide towers built without diagonals, is of unusual interest to the structural engineer, and at the same time is well proportioned as an integral link in a major transportation route through the city.

Wage Scale or Shirking?

AS WE WRITE, there are widespread beginnings of so-called "strikes" against the subsistence wage fixed by the government for relief work under the works program. This surprising movement is marked by labor-union leadership in some places, notably in New York; the union argument is that regular wage scales must be maintained, to avoid sacrificing something that took years of struggle to achieve. In other places there is no claim of upholding a wage scale, but barefaced desire to do no work at all or as little work as possible. While this shirking movement is going on, both city and country regions are reporting that it is hard to find labor, either because recipients of relief doles prefer not to work or because they are unwilling to accept the pay offered for work. Throughout, the earmarks of plain laziness and charity grafting are evident—even in the case of the unions that threaten to strike, since their whole fight is to do less work to earn the limiting allowable monthly relief-work pay. There can be no question of how this

issue will be decided; arrogant demands of self-seeking groups for preference cannot be permitted to wreck a constructive effort planned to assist the nation as a whole. And it goes without saying that engineers, whether engaged in normal occupation or in relief-work activities, will give no countenance to the spirit of relief loafing and shirking.

Floods and Local Responsibility

IT IS GRATIFYING to learn that New York State has acknowledged its responsibility in the matter of the flood hazards threatening the communities of its interior valleys, by seeking thorough information on future flood contingencies and possible safeguards. It is less gratifying to find that in doing so this state is content to delegate its responsibility to the federal government by asking that a flood survey be carried out by the Engineer Corps of the Army. The engineering problem of making such a survey is the state's own obligation, not that of the federal government. There is no reason why the state should lay its troubles in the lap of the great white father.

Concerning the seriousness of the flood hazard, there can be no question in the light of the facts. Accumulating data on peak flows during the downpours of the week of July 8 furnish convincing evidence. Many of the rivers involved far surpassed their greatest discharges ever before known, and but for the abnormally spotty character of the rainfall many others would have had equally disastrous experience. Flood events in nearby regions, as in 1913 and in the Muskingum Valley again last week, indicate the possibility of even greater disaster. Surely, nothing more is needed to demonstrate the urgency of searching flood study.

As to how such study should be approached, there can be equally little question. It is an engineering undertaking of difficulty and responsibility, but in no way different from other engineering investigations and planning that constitute the normal activity of the profession. In no sense is it the function of the national government to conduct such studies, nor does experience acquired in the national service peculiarly equip an engineer to carry them out. Granted that they call for a high order of technical ability and skill, they represent precisely the kind of problem for whose solution the civil engineering profession has developed.

Is engineering study of local floods a proper and necessary part of the federal government's service to its people? To this primary question the answer is clearly negative. Such being the case, we may freely acknowledge the ability of the army engineer officers and their civilian aides, and at the same time maintain that this ability should be devoted to the national service as such. The Engineer Corps is not maintained as a service agency for local government units, nor has the federal government any mandate to do the service work of states or cities. For a state, except in dire extremity, to call upon the nation to perform service work that is its own obligation constitutes an abdication of authority and avowal of incompetence.

New York State itself, it happens, numbers among its citizens a professional group of brilliant accomplishment, including some of the ablest hydrologists and administrators of technical study or construction. These men are not without honor save, it would appear, in their own home state. Morover, could the state not find adequately competent engineers among its own citizenry it still would be in a position to call to aid the most skillful students of hydrology and floods wherever they may be found. But the facile drift toward centralizing all troublesome responsibilities in Washington, even at the cost of abdicating the essential authority of the state commonwealth, appears to make it easy and convenient to disregard these resources.

It may be asserted that the problem has interstate aspects because some of the streams affected are interstate. Or, again, it may be urged that responsibility for just such a study was laid on the Corps of Engineers by an act passed by the 69th Congress calling for comprehensive studies of the major rivers of the country in the interests of flood control, navigation, irrigation and power development. Neither of these considerations is sufficiently strong to outweigh those that make the problem essentially local.

Obviously, the plans that the state authorities make for flood control must be tied in with similar plans by other agencies, to conform with those for general development of the streams concerned. But at best the army engineers' "308" studies can be expected to do no more than lay down general principles to be observed; working out the detailed studies and planning for their execution is, and should remain, a local matter. Just as the citizens of the Miami Valley and of Pueblo and Erie grappled with their own flood problem and built protective works, realizing that it was not the concern of Michigan or Texas or Montana to help them do so, so the citizens of New York State should realize at the outset that the problem is theirs alone, and that their own initiative and self-reliance will determine how early and how effectively they will be protected against floods.

Motor-Vehicle Regulation

REGARDLESS OF POSSIBLE DEFECTS, the Motor Carrier Act signed by the President last week is a much-needed piece of national legislation. Defects can be eliminated by amendments; national recognition of the principle that the regulation of all forms of public transportation should be under public control, as expressed in the act, is the significant element of new legislation.

Being federal, the new act relates primarily to interstate operations by bus and truck. Regulation of intrastate operations still remains in the hands of the state regulatory commissions. Some believed that all control of trucks and buses should remain in the hands of state commissions, but each year it has become more apparent that national regulation is necessary, chiefly to bring about uniformity but also to block the dodging of complete state control that was made possible by the simple expedient of operating in two or more states. Further, by placing responsibility for federal regulation in the hands of the Interstate Commerce Commission, the body now charged with regulatory control of the railroad carriers, such matters as rates and hours and conditions of employment on the railroads and highways should quickly be brought as near to uniformity as physical conditions and the public interest justify.

From the viewpoint of road planning, federal regulation should bring about the much-to-be-desired uniformity in load, length and other limits on motor vehicles. It also should result in elimination of the many abuses that have grown up and that are steadily raising up public hostility to unregulated freight movement on the highways. Under wise administration the new law will clear the way toward making our highway network more efficient and further its consistent development to meet the increasing demands of transportation.

CURRENT NEWS

WPA Wage Rates Modified Under President's Order

(Washington Correspondence)

AS A RESULT of the recent agitations over the "security wage," some concessions to organized labor have been authorized by President Roosevelt. By an executive order dated Aug. 5, and recently made public by the PWA, Harry Hopkins, Works Progress Administrator, is given authority to modify present requirement that all labor certified by U. S. Employment Service for the work-relief program must be drawn from relief rolls. This will permit employment of union men not now on relief rolls on both WPA and PWA projects.

There is no indication that the present WPA wage rates will be raised, although Mr. Hopkins holds authority to adjust them up or down or suspend them entirely. Local prevailing rates generally apply at present on all PWA low-rent housing projects and to non-federal public works projects financed by PWA grants and loans. Under present regulations, 90 per cent of all labor employed on PWA jobs must be certified from relief rolls. PWA housing projects are exempted from this restriction under certain conditions.

Anticipating that Mr. Hopkins will exercise promptly the discretion vested in him by President's order to employ non-relief union labor, PWA postponed from Aug. 12 to Aug. 29 the opening of bids on the Outhwaite Housing project in Cleveland.

Mr. Ickes was plainly disgruntled because he had not been consulted with reference to the revision of regulations affecting labor conditions. He declined to comment on the demand of A.F. of L., that all work relief projects be placed under jurisdiction of the PWA.

New York strike declines

Figures issued on Aug. 12 at the office of Hugh S. Johnson, WPA Administrator for New York City, although disputed by union leaders, indicated that the threatened strike of 10,000 or more skilled workmen on WPA projects was losing ground rather than gaining momentum. The administrator's office reported that only 656 men were out on strike on Aug. 12, which is 461 fewer than were out last Friday. The Central Trades and Labor Council, which had recommended the strike, declared that there were far more men out than the figures showed.

The strike was started over the so-called security wage of $93.50 per month. The union demanded that men be paid the prevailing hourly rate, but expressed willingness to be limited to a monthly earning comparable to the security wage.

A statement issued by William Green, president of the American Federation of Labor, to clarify organized labor's position, declares that representatives of skilled building trade workers felt that if they accepted the security wage on WPA projects, they would lose the prevailing rate of pay when employed by private contractors. In the statement the federation is willing to accept the monthly security wage for relief workers, including skilled labor. It adds only that the prevailing hourly standard wage rate be maintained in the payment of the monthly security wage. The executive council recommended that all WPA building and construction projects be transferred to the PWA which follows the rule of paying the prevailing rate of wages for all work coming under its supervision and administration.

Imperial Desilting Works To Have Dow Machines

A contract for silt-removing machinery for the desilting works at Imperial Dam, at the head of the All-American Canal, near Yuma, Ariz., was awarded to the Dow Company, Denver, Colo., on August 13. The contract price is $564,800. The desilting works comprise a series of sedimentation basins lying between the dam forebay and the canal. One side of each basin being supplied from the forebay by an influent channel and feeding the desilted water to an effluent channel on the opposite side. The effluent channels discharge into the canal. The influent channels also connect with the canal to bypass the basins whenever necessary. Each basin contains a series of rotary desilting scrapers. Bids on these machines were received early in July.

Plans Made To Collect Snow Depth Data

Efforts to systematize the collection of information regarding the depth of snow in Idaho are being made by the Department of Agriculture. Coordination of the efforts and the pooling of data collected by the forest service, national park service and bureau of reclamation for the entire watershed of the Snake River Valley is the immediate objective. At the present time the reclamation bureau has the most complete data through its monthly measurements of the Jackson Lake watershed, headwaters of the south fork of the Snake River.

The new program hopes to supply and correlate similar information for such watersheds on the Teton River, Blackfoot, Portneuf and Raft rivers, as well as on the north fork of the Snake River.

Work in Muskingum District Halted As Rivers Rise to Flood Stage

Wisconsin, Pennsylvania and West Virginia also swept by floods. China's Yellow River continues rise.

FLOOD control works in most sections of the Muskingum Conservancy District were halted as rivers in various sections of the country, fed by heavy rains, rose over their banks during the three days from Aug. 7 to Aug. 10, causing damages running into millions of dollars. The Muskingum watershed in Ohio experienced a storm similar, in intensity and extent, to that which devastated parts of New York state early last month. The same storm swept into western Pennsylvania and West Virginia. In Wisconsin, floods centering around the Kickapoo River did considerable damage. Latest reports from China indicate that flood conditions there are becoming worse.

Muskingum Valley flood

In Ohio, the worst flood since 1913 swept the south central part of the state. Lancaster and Fairfield counties, which on July 28 suffered considerable damage from floods, were once more swept by the high waters of the Hocking River. The damage done, however, was small. South of the Hocking and Scioto rivers damage mounted to $5,000,000, according to early unofficial reports.

A report by Maj. J. D. Arthur, Jr., district engineer of the Zanesville district, states that storms which occurred almost daily during the week of July 31 to Aug. 7 hindered work at all of the dam sites in the Muskingum watershed. Streams and rivers became torrents, overflowed their banks and brought construction to a standstill. Some minor operations were carried on between rains during the first part of the week, but these were discontinued when the waters began rising to flood stage.

At Beach City dam the contractor's bridge, undermined by high water, collapsed on Aug. 3. At the Dover dam site the Pennsylvania R.R. tracks were washed out but the cofferdam remained standing. Dam embankments at Clendening, Tappan, Beach City, Wills Creek, Mohawk, Charles Mill, and Senecaville remained above water. Work at all of the sites consisted of protecting, salvaging and repairing equipment. The big shovel in the Wills Creek outlet cut was entirely submerged except for the boom, and the water was 9 ft. over the contractor's bridge. During the flood period, all members of the engineering staff at the various jobs have been busy collecting flood data to aid in planning future reservoir operation.

Highest flood since 1913

A telegraphic report from T. T. Knappen, senior engineer in the U. S. Engineer Office at Zanesville states that the Aug. 7 to 9 highwater in the Muskingum basin is the only major flood which has occurred outside the December to April bracket and therefore caused unusually heavy agricultural losses.

(Continued on p. 241)

Additional Bonding Required On Public Works Contracts

Additional bonding of federal public works and building contracts over $2000 is required in amendment to the Heard Act reported favorably to the Senate and already passed by the House. The new bonding is designed to protect subcontractors and material men by giving them the right to sue 90 days after delivery of material, or performance of labor, if they have not already been paid in full. Present requirements for performance bonds protecting the Government are unchanged. The required amount for the second or new bond on contracts under $1,000,000 is 50 per cent; up to $5,000,000, 40 per cent, and on contracts over $5,000,000 the bond has been set at $2,500,000. The Associated General Contractors oppose the bill as unnecessary but it has been rushed through and seems likely to pass.

Denver Moving Fast on Extended Water Program

Following the passage July 29 by the Denver City Council of ordinances providing for $2,700,000 in general obligation bonds to build reservoir, conduits and filter plant to bring West Slope water into the city system through the Moffat Tunnel pioneer bore, an election will be held Sept. 10 on the question. Included in the referendum is the question of refunding the 4-per cent water-rent certificates which were voted as collateral to the PWA on the Moffat Tunnel lining and west slope collection system. Denver's credit and the market have so improved that its bonds can now be sold for 3¼ per cent or less according to the ordinance. Only $250,000 of these certificates have been issued and PWA has not disposed of them; they are redeemable Jan. 1 or July 1 of any year. The new appropriation of $2,700,000 is to be supplemented by a 45 per cent PWA grant of $2,137,500, already approved contingent on the outcome of the Sept. 10 election.

Principal items of the new project are the following: Ralston reservoir inlet extensions, including 3 mi. of canal and 4,000 ft. of siphon, $207,000; Ralston Creek reservoir, 11,000 acre-ft. capacity, including 2,000,000 cu.yd. embankment, 22,000 cu.yd. concrete cut-off wall, 50,000 sq.yd. slope paving, spillway and outlet works, $1,480,000; 12,000 ft. of 36-in. concrete or 42-in. steel pipe to Table Mountain, $120,000; 35,000 ft. of 42-in. concrete or 48-in. steel pipe and 2,000 ft. of steel siphon for filter plant, $455,000; a 40 m.g.d. filter plant, including a 10 m.g. clearwell, $885,000; 18,000 ft. of 54-in. concrete or 60-in. steel pipe line to existing Ashland Ave. reservoir in North Denver, $288,000; 21,500 ft. of connections in Denver, $390,000; 21,000 ft. of 60-in. concrete or 66-in. steel connection from Marston Lake to Conduit 13 to eliminate much pumping, $457,000.

The total estimated construction cost of this project, which is an extension of the Fraser River project bringing 54,000 acre-ft. per year into the South Platte water shed, is $4,475,000. Thus Denver will have two principal watersheds to depend on in case of a drought year.

Lining of the pioneer bore for the Moffat Tunnel to make it available as a water conduit was undertaken some time ago, as a preliminary to this larger undertaking.

Senate Passes Bill Regulating Wages On Government Work

WITHOUT A ROLLCALL, the Senate, on August 12, passed and sent to the House the Walsh bill empowering the government to impose maximum-hour and minimum-wage standards upon all those contracting with it. The bill applies to all contracts financed, even in part, by federal loans, grants or appropriations, whether made by governmental units or private parties using government funds. It also forbids the employment of convict labor or persons under sixteen years of age in carrying out such contracts.

Actual determination of the wage and hour standards to be required is left in the hands of the President or his agents, and he is given power to require of a contractor a pledge that he will apply these standards to his entire production until June 30, 1937, or for the duration of the contract. The provisions of the law apply also to subcontractors and material men.

Penalties for violation include cancellation of the contract or subcontract and the withholding of payments due. Such payments would be subject to claim by underpaid workmen, who are also given the right to sue against a contractor's bond. A principal contractor may relieve himself of liability with respect to persons not on his own payroll by requiring certificates of compliance from subcontractors and material men, but must cancel a subcontract when so ordered.

As reported in *ENR*, August 1, 1935, the Walsh bill was erroneously mentioned as an amendment to the Bacon-Davis bill. The Walsh bill is, in effect, an extension of the NRA codes to all government contracts. It is aimed at both construction contracts and those for supplies and materials used by the government, principally the latter. It is new legislation designed to keep the government from doing business with those attempting to cut wages.

The Bacon-Davis amendment applies only to government construction and repair contracts over $2,000. It provides for pre-determination of prevailing wage rates and their application to government construction, guards against "kick-backs," and puts force in the old Bacon-Davis act, which was weak in the enforcement provisions. This bill was passed by the Senate Aug. 1 and will probably be acted upon by the House soon.

Michigan Gets WPA Funds For Traffic Studies

An allotment of $451,120 has been made to the state of Michigan from WPA funds for various state-wide traffic studies and collection of data. A state-wide highway count and research project to cover volume, usage, speed determinations, intersection flow studies and tourist traffic and usage study was awarded an allotment of $230,900. A transportation and research project for the determination of selected points of annual traffic volume by continuous count for one year was awarded an allotment of $133,988, while state-wide tabulation of traffic data received an allotment of $86,232.

Details of Erosion Control Worked Out for 8 States

Details of the expanded erosion control program to be carried out in eight states with works program funds allotted to the Soil Conservation Service, have been made public by the Department of Agriculture. The states that are included so far in this program are Pennsylvania, Louisiana, Ohio, Minnesota, Maine, Alabama, Wisconsin and New Jersey. Demonstration projects are being set up in large areas of each state. The Soil Conservation program will be primarily one of demonstrating practical and effective measures of land protection and erosion control to farmers throughout the country. A complete land use and land treatment plan will be worked out in each project area.

Actual work will include strip cropping, construction of inexpensive check-dams for gully control, sloping and revegetation of gully banks, construction of diversion ditches and waterways and other mechanical devices for controlling excessive runoff of rain water. Planting of vegetation and contour cultivation, retirement of steep eroded slopes, reforestation, pasture management, crop rotation and similar practices will be used extensively either alone or in support of mechanical methods. Plans for each project area are mapped out in advance by agricultural engineers, soil experts, foresters and erosion specialists of the Soil Conservation Service and the program is carried out in cooperation with individual farm owners in the area. The work being done in each state is part of the national program involving the establishment of 93 new projects and the continuation of 47 existing projects in 42 states.

The program in Pennsylvania calls for the establishment of three new projects in Lancaster, Franklin and Westmoreland counties, and continuation of an existing project in Indiana County. An allotment of $559,311 has been set aside for the conservation work in Pennsylvania.

In Louisiana an allotment of $707,130 has been set aside for the establishment of four new projects, and continuation of one project already under way. For the work in Ohio an allotment of $517,345 has been set aside for the continuing of the existing project and the establishment of three new projects.

In Minnesota an allotment of $228,888 will be used for the establishment of one new demonstration project and the continuation of three existing projects. A sum of $500,908 will be used in Alabama to establish two new projects and for the continuing of the one project already under way.

In New Jersey an allotment of $302,969 will be used to establish new projects in Monmouth and Burlington and Camden counties. Wisconsin has been allotted $254,074 for the continuation of one existing project and the establishment of two new demonstration projects.

An allotment of $125,000 has been made to set up a soil erosion control project in Aroostook County, Maine. It is the first of its kind in that state. The new project will cover about 30,000 acres in the heart of the Maine potato country. In accordance with the provisions of the works relief act, 90 per cent of the labor to be employed on all these projects will be taken from local relief rolls wherever it is possible to do so.

Hopkins Declares that WPA Program Will Be In Full Swing By November

(Washington Correspondence)

SWEEPING aside the President's remarks to the effect that the peak in the relief works program may not be reached until next spring and that the federal government will continue to provide direct relief in states which refuse to assume that responsibility, Harry Hopkins insisted this week that 3,500,000 men would be employed and that all grants to the states for direct relief would end by November. Hopkins estimated that the states and cities have about $600,000,000 to provide relief for unemployables and declared that "there is no state in the Union which doesn't have the power and wealth to carry relief."

Despite relief strike threats, WPA is moving into action. Relief works programs now are replacing the dole in several states. Estimated employment of 550,000 men includes 425,000 in CCC camps, 105,000 on WPA state work programs and 20,000 on federal projects financed by WPA allotments. To August 13, partial relief works allotments totaling $212,000,000 had been made to 27 states, although New York City had received 48 per cent of the total. Indiana, Ohio, Georgia, Alabama, New Jersey, Michigan, Oklahoma, West Virginia, Arkansas and Pennsylvania have obtained approval for the largest work programs to date.

Mackall resigns as Maryland WPA Administrator

Attention was focused on Maryland's program by the resignation of John N. Mackall as state WPA administrator. Mackall charged that he had tried to obtain consideration from both WPA and PWA for the program that he had prepared. In his letter of resignation, withheld for several weeks at Hopkins' request, Mackall said that because of its emphasis on employment of relief labor and on speed, the WPA program is "coming back to the old CWA" and that the "results will be really more unsatisfactory because of the fact that projects already undertaken or completed are the most desirable and consequently those remaining for consideration are less desirable."

Mr. Mackall also stated that the ability of local governments to contribute to the new program also has declined. After a conference at the White House Senators Tydings and Radcliffe announced that the Maryland program developed by Mackall had been approved and the expectation is that it will be divided between WPA and PWA according to the size and nature of the individual projects. Baltimore will receive $22,000,000, to which it will add $11,000,000 and the counties will receive $12,000,000, to be augmented by local contributions, according to a statement by the senators. Ickes charged that Mackall had never submitted his program to PWA and had turned a deaf ear to suggestions that he do so because he was trying to "run the whole show" in Maryland. His successor is Francis M. Dryden. Abel Wolman is state PWA director.

No concern felt over relief strikes

No consideration has been given by the President and Hopkins to the demands of relief strikers for prevailing wages, despite threats by William Green, president of American Federation of Labor, that such agitation will spread. Hopkins declared that strikers will cut themselves off WPA rolls and that thereafter it is up to the states and counties to take care of them.

Hopkins issued an order this week establishing 120 hours a month as the minimum to be worked on WPA projects, excepting white collar activities. A maximum of 8 hours a day and 140 hours a month is fixed by regulations previously issued.

WPA STATE PROGRAMS, APPROVED TO AUG. 13

(Totals Represent Federal Allotments to 27 States)

Alabama	$9,983,555.00
Arkansas	4,917,847.00
California	667.00
Colorado	1,000,000.00
Delaware	38,891.00
Florida	1,992,568.00
Georgia	10,208,647.00
Illinois	3,122,707.00
Indiana	31,835,717.00
Kansas	300,000.00
Kentucky	1,461,596.00
Michigan	5,810,316.00
Minnesota	1,645,105.00
Nebraska	500,000.00
New Jersey	6,157,461.00
New York (State)	1,345,391.00
New York City	102,124,073.00
Ohio	10,247,444.00
Oklahoma	5,740,066.00
Pennsylvania	4,001,635.50
South Carolina	314,627.00
Tennessee	1,012,849.00
Texas	300,000.00
Vermont	550,380.00
Virginia	134,754.00
West Virginia	5,321,561.00
Wyoming	925,285.00
District of Columbia	1,236,713.00
Total	$212,229,855.50

X. H. Goodnough, Massachusetts Sanitary Engineer, Dies

X. Henry Goodnough, chief engineer of the board and director of the division of sanitary engineering of the Massachusetts Department of Health from 1914 until his retirement in 1930, died at Waterford, Me., Aug. 11, following a brief illness. Mr. Goodnough was 74 years old. Born in Brookline, Mass., and educated at Harvard University, Mr. Goodnough began his services with the state of Massachusetts in 1885, when he became connected with the state drainage commission. In 1886 he was made assistant engineer of the state board of health, and in 1895 he was appointed assistant chief engineer of the board. In 1914 he became chief engineer of the board and director of the division of sanitary engineering of the department of health. He also was consulting engineer to the Metropolitan District water supply commission.

Mr. Goodnough's passing removed one of the few remaining pioneers in state sanitary engineering. Through nearly a half century of service with the Massachusetts Board of Health, Goodnough had a strong and able hand in advising scores of cities and towns on plans for water works and sewerage. He took a leading part in the investigations and preliminary plans of the state board that led to the creation and established the major policies of the metropolitan sewerage and water districts, the first extensive districts of the sort in this country.

As successor to Frederic P. Stearns, the first chief engineer of the Massachusetts Board of Health, Goodnough continued the policy of the former that led the district to go farther and farther westward for water until the tributaries of the Connecticut, an interstate stream, were turned eastward to Boston and adjacent municipalities. A notable contribution by Goodnough to the Ware-Swift or Quabbin project, now well under way, was the proposal to divert floodflows only. The upholding by the United States Supreme Court of diverting floodwaters to another drainage area was a tribute to the judgment of Stearns, Goodnough and their associates. For a time it looked as though the westward extension would be thwarted by opponents who advocated taking nearer and polluted sources that would require purification, but the legislature finally supported the policy of Stearns and Goodnough.

Through his long career, Mr. Goodnough ably sustained the Massachusetts policy of controlling stream pollution and of utilizing unpolluted sources of water supply rather than taking doubtful or dangerous sources and subjecting them to purification. Rarely was the advice on water supply and sewerage which the state board a half century ago was authorized to give municipalities overruled by the state legislature, which retained the final decision in all such matters.

Sewer Construction Program At Montreal Reconsidered

Faced with over $300,000 worth of claims for damages, following recent severe flooding in the northeastern section of the city area, the city of Montreal has taken further action with regard to its uncompleted sewer program. City officials conferred this week with L. E. Potvin, president of the Quebec Municipal Commission, who must authorize the proposed $3,000,000 loan, and it is understood that, if the proposed expenditure on the city waterworks intake at Ville Lasalle is kept to a minimum, the money for this loan may be forthcoming. The proposed construction consists of two large trunk collector sewers, and the necessary connecting sewer work.

Recently the plans prepared by the Montreal Sewers Commission were submitted to Beaudry Leman, manager of the Banque Canadienne Nationale, one of the city's banks partially controlling city expenditure at present. Mr. Leman is a civil engineer by training, although a banker by profession. The city authorities hope that his engineering experience will enable Mr. Leman to convince his bank, and the Bank of Montreal, with whom they are associated, that this link in the city's sewerage system should be built without delay.

Discussion of the proposed new waterworks intake for the City of Montreal, from the River St. Lawrence, which has been to the forefront of civic affairs for several months past, still continues. An independent study of various proposals has now been made, and it is understood that the mayor of the city is satisfied that by the expenditure of between $300,000 and $400,000, the existing intake can be repaired.

High Floods in Ohio and Wisconsin

(Continued from p. 238)

The flood was the result of an intense storm of twelve to fourteen hours duration which produced concentrations of rainfall on the central part of the watershed averaging roughly 7 in. The average rainfall for the entire watershed which has a drainage area of 8,038 sq.mi. was approximately 3.35 in. The maximum record rain of 8.7 in. at Newcomerstown exceeds the previously recorded Ohio maximum rate of 7.4 in. for 24 hours. (See map on p. 233.)

The Muskingum River and all its tributaries were out of bank, with the flood particularly severe on Killbuck Creek (above Wooster), Wills Creek, Walhonding River, Tuscarawas River, and the main stem of the Muskingum River. At Coshocton and Zanesville the flood is the highest recorded since 1913.

Highways, bridges and towns suffered heavy damages. Almost all highways in the basin were closed during the flood with many of them still impassable due to washouts. Extensive urban damages occurred at Massillon, Newcomerstown, Coshocton, Newark, and Zanesville.

According to a telegraphic report from Lyman C. Lam, resident engineer of highways, Coshocton, Ohio, the estimated damage to highways and bridges in Coshocton, Guernsey, Muskingum, Perry, Fairfield, Licking and Knox counties amounted to more than $500,000.

Floods in Pennsylvania and West Virginia

The Cowanesque River, in northern Pennsylvania, just south of the New York area which was devastated early last month, swept through Osceola, Westfield and Elkland on Aug. 10. The river, rising 40 ft. in two hours, caused widespread damage over a 30 mile area. Loss to railroads, highways, homes and crops was estimated at $100,000. At Osceola, 20 miles south of Corning, N. Y., two buildings were completely wrecked by the flood. Branches of the Baltimore & Ohio and Erie railroads in the Cowanesque Valley reported heavy losses, and it will probably be two days before service can be resumed.

The same storm that swept the Muskingum watershed evidently passed into West Virginia and western Pennsylvania, causing property damage estimated, in early reports, at more than $750,000. The Northwestern turnpike between Foxburg and Parkersburg, W. Va., was inundated in several places and the towns of Harrisville, Cairo and Pennsboro in Ritchie County were isolated as the highways were impassable. The Buckhannon River threatened many towns in the vicinity of Foxburg with complete isolation. In the vicinity of Wheeling, 12-hour rains brought an estimated property damage of $250,000.

Floods in southwestern Wisconsin

Heavy and concentrated rainfalls on the evening of Aug. 6 in southwestern Wisconsin produced record floods in a number of streams and wrought much local destruction. The principal rivers affected were the Baraboo, LaCrosse and Kickapoo.

The area principally affected is the roughly rectangular territory north and west of the Wisconsin River, extending west to the Mississippi, bounded by LaCrosse, Portage, Madison and Prairie du Chien. The most intense precipitation appears to have been on the headwaters of the Baraboo River at Hillsboro, 3.9 in., which the city attorney states fell in 1½ hrs. Damage here was increased by the failure of a small earth dam, which, though heavily covered with willow growth, was breached when overtopped, washing away the railroad station and bridge and doing much damage to other property below. Another small dam failed at Cazenovia, 15 miles to the southeast on a tributary of the Baraboo; LaValle at the mouth of this tributary had its low-lying areas submerged. The flood in the Baraboo is believed to have exceeded all prior records.

Rainfall and stream data are given as follows by M. W. Torkelson, director of the Wisconsin Regional Planning Committee: LaCrosse, 2.12 in.; Viroqua, 1.61 in.; Hillsboro, 3.9 in.; Baraboo, 3.0 in.; Portage, 3.0 in.; Madison 3.18 in. The Kickapoo River, with a total drainage area of about 520 sq.mi., is estimated to have had a 24-hr. rainfall of 3.5 in. average, and the Baraboo River, with a drainage area of about 550 sq.mi., 2.7 in. The total rainfall on the two areas is estimated at 98,200 acre-ft. and 81,500 acre-ft. respectively.

Levees along the Baraboo River between Baraboo and Portage broke, causing much crop damage. The Kickapoo valley, which is narrow with steep side slopes, had the branch line of the C.M.&St.P. from Wauzeka to LaFarge largely washed out, and crops on the valley floor were destroyed. The highwater mark at LaFarge is reported to have been 13 in. above the level of the 1907 flood, considered the highest on record.

Railroad damage may reach $100,000. Highway damage will probably reach double this figure, nearly half the damage being on county and town roads. A number of minor bridges were carried out, but no well-built or modern structures. Crop damage and losses in cities and towns in the flooded area are extensive. Estimates of total damage are incomplete but the figure may reach $1,000,000. One fatality is reported.

ABNORMAL RAINS in the Muskingum River Valley in Ohio, following closely upon a series of rain storms, sent many of the streams of the valley over their banks. This picture shows conditions at Coshocton, near the center of the valley

China's Yellow River continues rise

Reports from Kaifeng, China, on Aug. 10, asserted that dangers from Yellow River flood were increasing as the river reached its highest level since that reached in the 1931 flood.

J. D. Ross Appointed Consultant To PWA Power Division

J. D. Ross, Seattle municipal power plant operator, has been appointed chief consulting engineer of PWA's recently organized power division and will assume his duties in Washington next week. Other appointments to the division set up under the direction of Dr. Clark Foreman, include Samuel Becker, former PWA attorney in Wisconsin, to head the legal division and K. Sewell Wingfield, as assistant director of the power division. Mr. Wingfield was transferred from PWA's finance division.

Administrator Ickes expressed gratification that PWA has been able to obtain Mr. Ross's services and said that Mr. Ross will proceed rapidly with the examination of project applications submitted by local governments.

Taylor Dam Diversion Tunnel Holed Through

The diversion tunnel for the Taylor reservoir in the Uncompahgre project near Gunnison, Colo., was holed through on Aug. 8. From preliminary survey lines, grade and center of the tunnel appeared to check perfectly although the tunnel had not yet been cleared.

Boring of the tunnel, which is 1,100 ft. long, completed one of the major parts of the construction of the earth and rock fill Taylor dam. Water which will be impounded by the dam will be used for the Uncompahgre irrigation project around Montrose and Delta.

PWA Takes Options on Land For Chicago Housing Project

Options on 17-acre site for a low-cost housing project on northwest side of Chicago have been accepted by PWA. The allotment for the development, which is the fourth now in progress in Chicago, is $2,750,000. The land to be purchased is bounded on the South by Diversey Parkway, on the West by the North Branch of the Chicago River, on the North by Oakdale Ave., and on the East by Claybourn Ave. The new site is first vacant property acquired for PWA housing in Chicago, although vacant land was recently bought as a nucleus for the Jane Addams Housing project.

Low Price Set for Land at Grand Coulee Dam

A value of $17,389 for 1,104 acres of land at the site of Grand Coulee Dam on the Columbia River in Washington was set on Aug. 3 by a jury in condemnation proceedings instituted by the government in the federal court at Spokane. The land owners asked $5,000,000 and the government had offered $15,300.

Witnesses for the landholders attempted to demonstrate that the project was one that would attract private capital and that hence their land, including as it did the best site for a dam, had a high value. Engineers for the Bureau of Reclamation, who are building the project, claimed that the project was not one to attract private capital, and that on account of Indian and government lands involved the project only was feasible as a federal undertaking.

Judge S. S. Webster instructed the jury that the value of the land as a dam site could not be considered, that their function was to determine the fair market price of the land at the time the government took it.

SOCIETY CALENDAR

PUBLIC WORKS ENGINEERING CONFERENCE, joint meeting of the American Society of Municipal Engineers and International Association of Public Works Officials, Cincinnati, Ohio, October 14-16.

INSTITUTE OF TRAFFIC ENGINEERS, Sixth annual meeting at Louisville, Ky., October 15-16.

AMERICAN SOCIETY OF CIVIL ENGINEERS, fall meeting, Birmingham, Ala., Oct. 16-18.

AMERICAN ASSOCIATION OF STATE HIGHWAY OFFICIALS, annual convention, Miami, Fla., December 9-12.

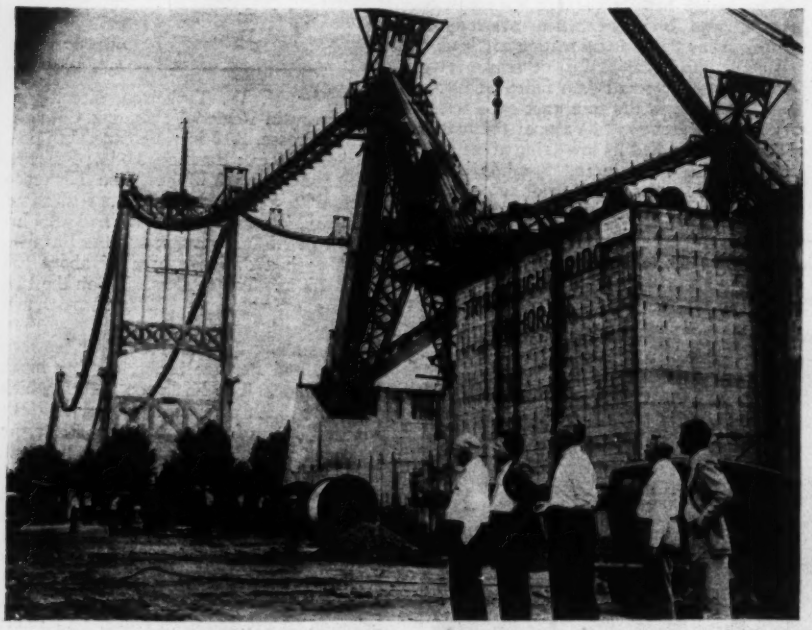
AMERICAN WATER WORKS ASSOCIATION, Central States Division, Pittsburgh, Pa., August 22-24.

NEW ENGLAND WATER WORKS ASSOCIATION, fall convention, Providence, R. I., Sept. 17-20.

NEW ENGLAND AND NEW YORK STATE SEWAGE WORKS ASSOCIATIONS, joint meeting at Schenectady, N. Y., October 4-5.

EXAMINATIONS for registration of engineers will be held in the near future as follows:

IOWA—By Iowa State Board of Engineering Examiners at the State House, Des Moines, Sept. 4-5.



SPINNING OF CABLES ON TRIBOROUGH SUSPENSION BRIDGE COMPLETED

With the spinning of the two 20⅜-in. diameter cables of the Triborough suspension bridge in New York completed, interested officials look over the possibility of starting stiffening truss and floor steel erection by Sept. 1. Left to right are H. W. Hudson, engineer of construction, Triborough Bridge Authority; Earl Andrews, general superintendent of parks, New York City; Paul Loeser, director, Triborough Bridge Authority; Harry Taylor, New York City park department; and Sidney Shapiro, in charge of engineering for the Long Island State Park Commission. All of these organizations play a part in the Triborough bridge project, the city park department being concerned with the development of Randall's Island where the junction of the arms to the three boroughs occurs, and the Long Island State Park Commission being in charge of building the Queens connecting road.

Cable spinning was begun on April 23 and was completed July 12. Squeezing of the cables and installation of the cable bands were finished two weeks ago. Also the footwalks were lashed to the main cables and the footwalk cables removed and returned to the shop where they are being cut into suspender ropes and socketed. Installation of these suspenders over the cable bands is getting under way.

Washington Highlights

By Paul Wooton

Plans are practically complete for the new construction section in the Division of Marketing Research of the Bureau of Foreign and Domestic Commerce. This section was provided for in the budget which became effective July 1. It will deal exclusively with research on the economic side of construction. It will bring together statistical information from government and non-government sources. It will deal chiefly with information concerning factory and commercial buildings.

Merchant marine legislation depends upon the length of the present session of Congress. If the session lasts until mid-September a merchant marine bill likely will be passed. It will be a compromise between the measure passed by the House and the one drafted by Senator Black, head of the ocean mail investigating committee. The Senate bill limits profits to 6 per cent. The construction subsidy is limited to 40 per cent of cost.

While the social security act is regarded as the meager beginning of a great permanent program, it is recognized as the most decided step away from rugged individualism ever taken. Its sponsors see in it the Magna Charta of the aged, the unemployed and the underprivileged.

As amended by the Senate Finance committee the tax bill is designed to produce $269,000,000 in new revenue. Heavier levies are made on smaller incomes with surtaxes on larger incomes much as suggested in the President's message. Surtaxes jump from 60 per cent at $1,000,000 to $1,500,000 to 75 per cent on surtaxes over $10,000,000. The committee eliminated the inheritance taxes carried in the House bill and substituted higher estate taxes.

Washington, August 12, 1935.

Obituary

ARTHUR D. LITTLE, chemical engineer and president of Arthur D. Little, Inc., Cambridge, Mass., for the past 26 years, died suddenly at Northeast Harbor, Maine, on Aug. 1. He was born in Boston in 1863 and was graduated from the Massachusetts Institute of Technology in 1885. Much important work on cement and other materials of construction was done under his direction.

HENRY CAMPBELL EASTMAN, who had charge of land filling on Rikers Island for the New York City department of sanitation, died Aug. 11, at the age of 50. Mr. Eastman, who had attended the United States Military Academy at West Point, later became engaged in engineering work and during the war served with the British Royal Engineers in railway and transportation service. In 1934 he was appointed as assistant superintendent and was later made superintendent of the work on Rikers Island.

FRANK C. SHEPHERD, consulting engineer of the Boston & Maine R.R. since 1927, died at his home in Newton, Mass., on Aug. 6. He was born in Gloucester, Mass., 64 years ago and graduated from the Massachusetts Institute of Technology

in 1892. For a time he was resident engineer of the New York Central R.R. He joined the Boston & Maine staff as construction engineer in 1912. At the time of his death he was chairman of a committee investigating the inroads of termites and other insects on piling along the New England coast. Mr. Shepherd was also chairman of the American Railway Engineering Association committee on wood preservation.

FRED D. MCCUTCHON, retired chief engineer of the Gulf & Ship Island Railroad, died at his home in Pass Christian, La., on July 30, at the age of 82. He graduated from Virginia Military Institute in 1873 and shortly after became engaged in railroad development around New Orleans, later entering the service of various street railway companies in New Orleans. In 1905 he became chief engineer of the Gulf & Ship Island Railroad and held that position until his retirement in 1909.

OSCAR VAN PELT STOUT, of the Berkeley, Calif., office of the Bureau of Agricultural Engineering, died August 4, at Denver, Colo. He was 70 years old. His activities with the U. S. Department of Agriculture date back to 1899 when he served as engineer and consultant in irrigation and drainage investigations. Mr. Stout invented the proportional weir, and was the author of many bulletins on irrigation. From 1922, until recently, he was employed on cooperative irrigation investigations in California, and at the time of his death was detailed on special work for the Reclamation Service.

For many years he was dean of College of Civil Engineering, University of Nebraska, and was largely responsible for the introduction of agricultural engineering into the curriculum at the University. Mr. Stout saw active military service in France as a Major of Engineers. He received his bachelor's degree in civil engineering, his professional degree and an honorary doctor's degree from the University of Nebraska.

CONSTRUCTION STATISTICS OF THE WEEK

HIGH FEDERAL AWARDS push this week's total for engineering construction to $45,028,000, only $24,000 under the record high week for this year, that ending April 11. This total is made up: private, $6,870,000, and public, $38,158,000, of which federal is $24,886,000 and state and municipal, $13,272,000. This is the second high week in succession, topping last week's total of $35,596,000. The corresponding statistics for the same week last year are: total, $18,944,000, private, $2,015,000 and public, $16,929,000 of which federal was $3,611,000 and state and municipal, $13,318,000.

High earthwork and waterway contracts are responsible for $17,463,000 of this week's record volume. Public building awards are responsible for $10,585,000 more. Streets and roads score a substantial increase this week to $7,787,000 and industrial buildings are up to $6,083,000. Waterworks awards are low at $337,000 and bridges at $461,000 while sewerage is higher at $1,005,000.

The larger awards for the week include: Interior Department Building, Washington, D. C., $9,258,000; tin plate rolling mill for Bethlehem Steel Corp., Sparrows Point, Md., $5,000,000; highway awards by Michigan, $2,506,000, by New York State, $615,000; and by Missouri, $670,000; sewage treatment plant for Washington, D. C., two contracts, $719,000; excavation, Barge Canal, by Department Public Works, New York, from Oak Orchard to Three Rivers, $648,000, from lock 10 to 13, $1,009,000, from lock 19 to 20, $414,000, from Oneida Lake to Oak Orchard, $924,000; and federal awards: constructing lock 17, Mississippi River, New Boston, Ill., $1,882,000; levee work, Monroe, La., $573,000; gantry crane and gates for power house and dam, Bonneville Dam, Ore., $1,321,000; constructing lock and dam 9 and altering dam 8, Allegheny River, Pa., $1,822,000; dredging in Chesapeake and Delaware Canal, 3 contracts, $2,191,000; and another contract at $797,000; dredging, Hog Island Channel in Buzzards Bay, two contracts, $2,239,000; breakwater, Los Angeles, Calif., $828,000.

New capital for the week includes state and municipal bond sales, $2,284,000, PWA allotment approved by the President, $18,434,000 for non-federal work and $3,617000 for federal work including the 25 per cent of WPA allotments approved. $505,000 is added from amounts contributed by local sponsors of WPA projects. The total increase in new capital is $24,840,000.

CONTRACTS
(Thousands of Dollars)

	Weekly Average August 1934	Prev. 4 Weeks	Week Aug. 15 1935
Federal Government	$6,382	$7,282	$24,886
State and municipal	11,400	11,861	13,272
Total public	$17,782	$19,143	$38,158
Total private	4,041	7,402	6,870
Week's total	$21,823	$26,545	$45,028
Cumulative to date:			
1934...$885,147,000	1935...$845,822,000		

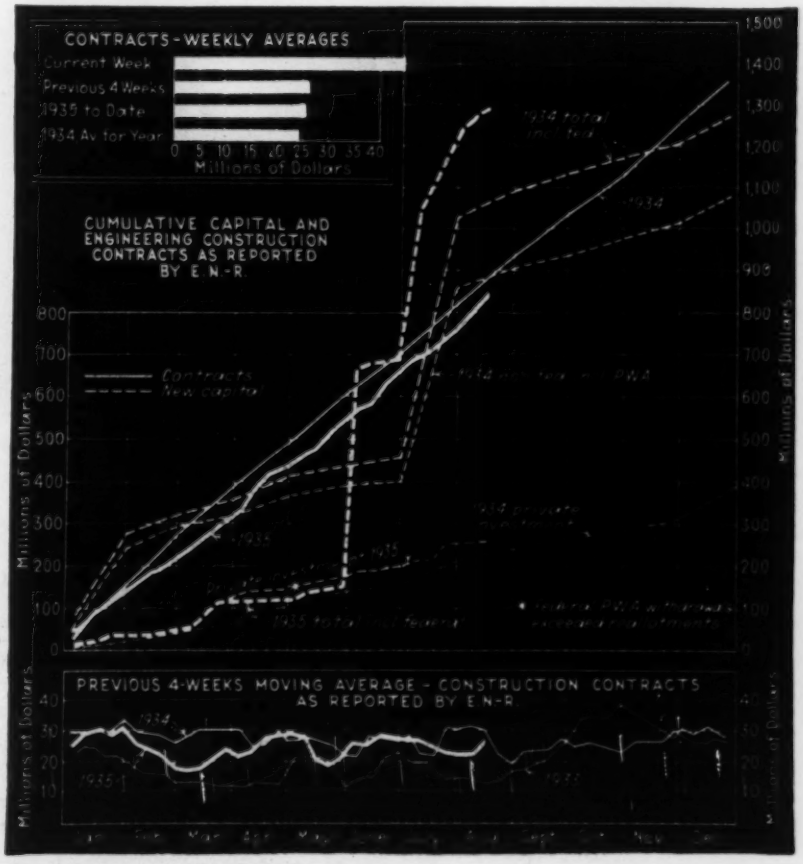
NEW PRODUCTIVE CAPITAL
(Thousands of Dollars)

1935	Week Aug. 15	Cumulative
State and municipal	$2,284	$258,900
PWA allotments, S&M.	18,434	248,272
RFC loans, S&M.	.....	36,084
Corporate issues	.....	18,124
PWA private	.....	8,629
Local contrib. to WPA	505	2,956
Total non-federal	$21,223	$572,965
PWA federal	3,617	719,303
Total new capital	$24,840	$1,292,268
Cumulative to date:		
1934..$1,055,570,000	1935..$1,292,268,000	

Note: These figures include private bonds, and stocks sold for productive purposes; state and municipal bonds for construction; PWA loans and grants to states and municipalities, including the special highway funds; PWA private loans, and allotments for Federal construction. An arbitrary percentage (25%) of the WPA allotments and local contributions to WPA work is included to allow for the capital additions through the Works Progress Administration division of the new program.

INDEX NUMBER

ENR Cost	1913 = 100	1926 = 100	ENR Volume	1913 = 100	1926 = 100
Aug., 1935	195.10	93.82	July, 1935	96	42
July, 1935	195.18	93.82	June, 1935	122	54
Aug., 1934	198.40	95.37	July, 1934	128	56
1934(Av.)	198.10	95.23	1934(Av.)	114	50
1933(Av.)	170.18	81.80	1933(Av.)	102	47
1932(Av.)	156.97	75.45	1932(Av.)	127	56



Construction Equipment and Materials

Improved Concrete Placer Has Automatic Gunman

A new pneumatic concrete placer having many improvements over the older type equipment is being marketed by the Pneucrete Equipment Co., Los Angeles, Calif. The recently developed Pneucrete Placer is a much smaller and more compact unit and because of its size can be fed directly from the mixer spout. An automatic gunman controls the placer so that only a nozzleman is needed to operate it.

The mixing chamber has only one moving part, a spherical rubber measuring ball which acts also as a valve to prevent air leakage and which has the added feature of being easy to clean. Both wet and dry mixes can be used in the placer. Hydration of the dry mix is controlled by a water valve on the nozzle. The new placer, which is less expensive both in initial and operating costs, has a daily output of about 40 cu.yd. per day and weighs much less than the old placers.

Cart Designed for Handling Bulk Materials

A materials cart, with a volume of 11 cu. ft., designed to handle a 1,900 lb. load is being manufactured by the Pittsburgh-Des Moines Steel Co., Pittsburgh, Pa., under license granted by the Omaha Trailer & Equipment Co., Omaha, Neb.

The Ayrgo cart is adapted to construction, factory and street department use. The body design eliminates handling of bulk materials as the cart may be loaded by running the scooping lip into the material and bringing the cart to an upright position. Pneumatic tires and roller bearings allow one man to handle a much greater load than he could ordinarily do. The Ayrgo is made of welded steel and weighs 260 lb.; it is 30 in. high and has a 3-ft. tread.

Pneumatic-tired Ayrgo materials cart

Pump Company Simplifies Design of Centrifugals

New features simplifying the construction of Humdinger centrifugal pumps have recently been made by the Ralph B. Carter Co., Hackensack, N. J. Among the more important improvements is the elimination of valves in the suction line at the pipe and in the hose to assure against the loss of prime by sticking valves caused by sand or other solids. Other changes are the elimination of several separate parts and a more compact design. These pumps, which are equipped with double ball bearing pump support heads and full flexible couplings, are made in sizes ranging from 2 in. to 8 in. and have fully automatic priming on suction lifts up to 28 ft.

Side and Rear Discharge Feature Transit Mixer

A transit concrete mixer of 1 cu.yd. capacity, mounted on a light weight truck is now being marketed by the Concrete Transport Mixer Co., St. Louis, Mo.

The Concrete Transport Mixers have helical mixing blades to assure thorough mixing at all consistencies. The speed of the blades may be altered for mixing and discharging at any desired rate. Open top construction lends itself to easy charging and cleaning. Discharging chutes are located at both side and rear of the mixer, allowing easy placement.

1 cu.yd. Concrete Transport Mixer

These mixers, of light weight but rugged construction, have few moving parts and are easy to operate. They are also adaptable for mixing asphalts and road oils as well as concrete.

New Equipment in Brief

Heavy Duty Air Hose. A new type of hose for pneumatic tool service, the Super Royal Cord, is being manufactured by the U. S. Rubber Co., New York. This air hose is built on the same principle as a cord tire with its cords laid in rubber to prevent rubbing or shearing. Resistance to pulsation, flexing and sudden pressure is said to be offered by this construction as well as resistance to bruises and abrasions.

Electric Generator Plant. To meet the requirements demanded for lighting equipment for night construction work the Hutchinson Engineering Works, Chicago, Ill., has developed electric generating plants driven by 1 and 2-cylinder gasoline engines. Direct current is generated in either 32 or 110 volts and 800 watts by a 1-cylinder engine and 1,000, 1,500 and 1,700 watts by a 2-cylinder engine. The generating plant is compact, with generator and fuel tank mounted close to the engine, so that the entire unit may be covered by a hood for all-weather service. The fuel tank has capacity enough to run the unit about 12 hr.

New Publications

PORCELAIN STEEL MODERN BUSINESS UNITS, Porcelain Steel Buildings Co., Columbus, Ohio. 8½x11, 24 pages.

NEW TAP CHART, R. G. Hoskins Co., Chicago, Ill. 8½x11, 4 pages. A per cent of thread chart for tapping equipment uses.

PROTECTION PLUS WITH MSA SKULLGUARDS, The Mine Safety Appliance Co., Pittsburgh, Pa. 8½x11, 4 pages.

BURKS CONDENSATION RETURN UNIT, Decatur Pump Co., Decatur, Ill. Bulletin No. 105.

ASPHALT TILE FLOORING, Johns-Manville, New York City, 8½x11, 6 pages.

AIR OPERATED COMBUSTION CONTROL, Bailey Meter Co., Cleveland, Ohio. 8½x11, 32 pages.

INDUSTRIAL HEAD AND EYE PROTECTION, Chicago Eye Shield Co., Chicago, Ill. 8½x11, 19 pages.

THE LIGHT SEALAIR WINDOW, The Kawneer Co., Niles, Mich. 8½x11, 8 pages.

FREFLO VERTICAL SEWAGE PUMPS, Worthington Pump and Machinery Corp., Harrison, N. J. 8½x11, 8 pages.

TERMITES AND FIRES, C-A Wood Preserver Co., St. Louis, Mo. 3½x6¼, 16 pages.

SOUND CONTROL OF MECHANICAL EQUIPMENT, Johns-Manville, New York City. 8½x11, 16 pages.

GUIDE FOR SELECTING V-BELT DRIVES, Gates Rubber Co., Denver, Colo. 8½x11, 48 pages.

QUIMBY DOTY RUBBER-LINED PUMPS, Quimby Pump Co., Newark, N. J. 8½x11, 4 pages. Bulletin C-112.

TWENTY-FIVE YEARS OF FEDERAL TRUCKS, Federal Motor Truck Co., Detroit, Mich. 11x13, 32 pages.

PRICE LIST AND CATALOG 32, Paint-Point Products Co., Brooklyn, N. Y. 32 pages.

ASPHALT PENETRATION MACADAM, The Texas Co., New York City. Photographs and specifications.

INLAND COPPER ALLOY STEEL, Inland Steel Co., Chicago. 3½x6¼, 6 pages.

THIOKOL OIL PROOF SYNTHETIC RUBBER, Thiokol Corp., Yardville, N. J. 4x8, 6 pages.

ROTOBLAST AIRLESS BLAST CLEANING, Pangborn Corp., Hagerstown, Md. 8½x11, 8 pages.

Business Notes

KALMAN STEEL CORP., Bethlehem, Pa., announces the appointment of R. W. Johnson as assistant sales manager. Mr. Johnson at one time had been assistant city engineer of Indianapolis, Ind.

FULLER COMPANY, Catasauqua, Pa., manufacturer of "Airveyor" pneumatic conveyors, compressors and vacuum pumps has opened a branch office in San Francisco. J. M. Alonso, former manager of the Chicago office will be in charge.

HALL LABORATORIES, INC., have obtained the service of Dr. Everett P. Partridge as director of research. Dr. Partridge, in 1931, was appointed supervising engineer of the U. S. Bureau of Mines experiment station at Rutgers University.

THE UNIVERSAL ATLAS CEMENT CO., Chicago, Ill., has announced the appointment of R. M. Beaton as district sales manager, in charge of metropolitan New York and northern New Jersey territory; B. J. Whittaker, district sales manager in charge of New York state territory; C. L. Whalley, assistant district sales manager, Newark, N. J. Under the supervision of Mr. Beaton he will have charge of northern New Jersey territory.

THE BRIGGS MANUFACTURING CO., Detroit, Mich., has appointed A. S. Ault, formerly ceramic control engineer for the General Electric Co., control engineer in charge of ceramics in the plumbing ware division. Martin A. Rooney will become eastern regional manager for the plumbing division of the Briggs Manufacturing Co.